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strip chart recorder

VIKING LABORATORIES INC.
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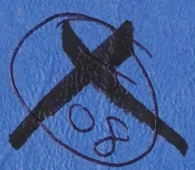
series G-22A



INSTRUCTION MANUAL

varian aerograph
2700 mitchell drive/walnut creek/california 94598/415-939-2400
specialists in chromatography and data handling systems

SERIES G–22A

DUAL CHANNEL RECORDER

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recorder products

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introduction

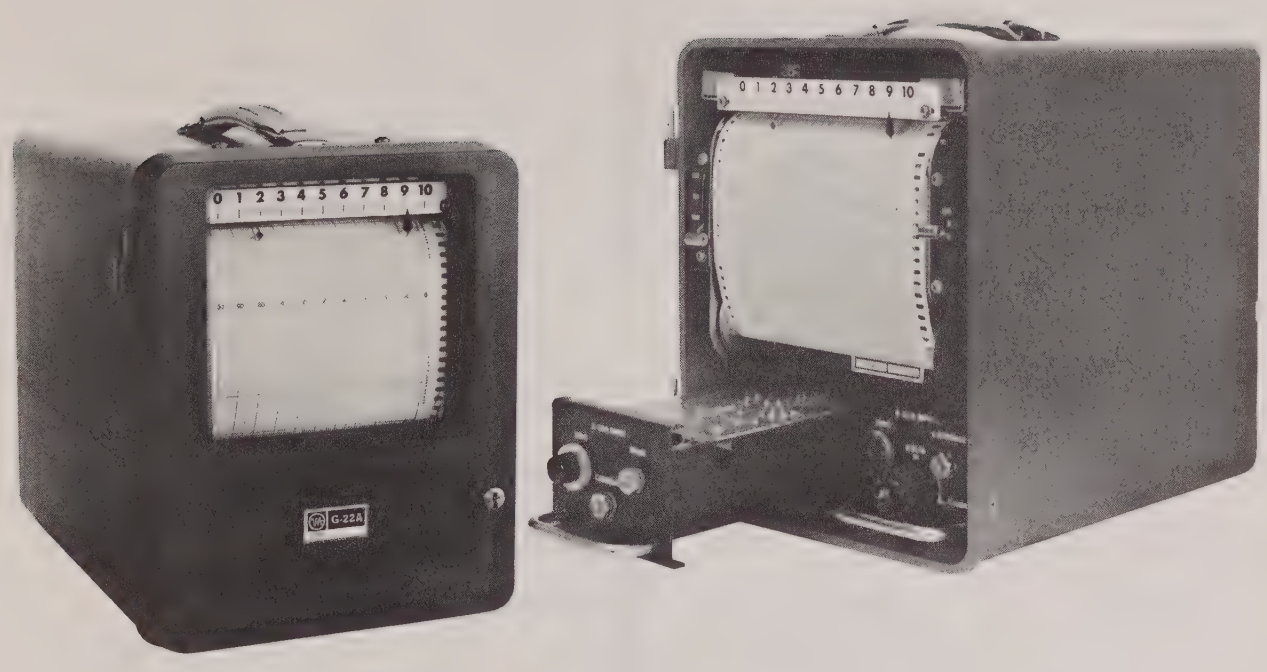


Figure 1-1: Model G-22A Dual Channel Recorder

1.0 INTRODUCTION

1.1 SUMMARY

The Varian Model G-22A is a dual-channel strip chart recorder. It contains a chart drive system, a pen and ink system, and two mechanically and electronically independent recording channels. Operation is based upon the null balancing method incorporating a closed-loop servo system. The unit is constructed along modular lines, utilizing plug-in assemblies for compactness, and convenience in service and maintenance. A variety of input chassis types, each designed to accept different forms of input signal information, is available. The standard Model G-22A Recorder is available in a wide range of chart speeds. A chart speed shifter external to the chart drive motor provides two chart speeds in each motor speed range. If desired, the recorder can be supplied with two chart drive motors, providing four chart speeds. The pen and ink system is comprised of capillary pens and large ink cartridges, allowing prolonged operation without replacement. The Model G-22A is housed in a die-cast aluminum portable case which may be panel mounted

1.2 APPLICATION

The Model G-22A Recorder can be used for correlation and simultaneous readout of two independent functions. It will record any phenomenon which can be transduced to a d c voltage or current. The unit does not load the measured source appreciably, and signals with currents in the microampere range are measurable.

1.3 EQUIPMENT SUPPLIED

Basic equipment supplied with the Model G-22A Recorder in portable or panel-mounted forms includes the following items:

1. One G-22A ink kit, containing:

2 red ink	2 piercing & priming units
2 blue ink	1 ft. pen cleaning wire
1 pen filler	2 ft. tubing

2. One roll chart paper
3. One power cord
4. One instruction manual
5. One registration card
6. Two oz. motor oil
7. Two fuses
8. One battery cell (with A-21A input)
9. One hardware kit (panel mounting only)

1.4 GLOSSARY OF TERMS

The following are standard industry terms used to specify recorder performance and will be used in this manual.

Dead Band Range through which measured quantity may be varied without instrument response, defined as twice the sensitivity and expressed as a percentage of full scale.

Error Voltage Difference between input voltage and reference voltage

Pen Speed Velocity of the pen in inches or centimeters per second

Input Signal Signal at recorder input terminals

Limit of Error Difference between the indicated and true value of measured quantity. (Does not include transducer errors.)

Full-Scale-Step Response Time
Required time for the instrument to achieve a full span change of pen deflection when a full-span step input signal is applied to the input terminals.

Range (measurement range)
Region covered by span and expressed by stating two end-scale values. Examples: 0 to 100 millivolts; 35, 0, –35 volts.

Span (full span)
Algebraic difference between the top scale value and the bottom scale value of the quantity being measured.

1.5 SPECIFICATIONS

These specifications apply only to the Model G-22A main recorder assembly, and do not include chassis specifications. Refer to Section 2 for complete specifications and tube complement of input chassis.

Full Span Balancing Time
One second with full-span step input

Chart Speeds (See paragraph 6.1)

Basic Speed (shifter in HIGH)	2nd Speed (shifter in LOW)
½ inch per hour	⅛ inch per hour
1	¼
2	½
3	¾
8	2
12	3
15	3¾
20	5
24	6
30	7½
1 inch per minute	15
2	30
4	1 inch per minute
6	1½
8	2
15	3¾
16	4

Power Requirements
110 vac—120 vac, 50/60 ±2 Hz, 65 w, single phase
220 vac—240 vac, 50/60 ±2 Hz, 65 w, single phase

Tube Complement
2—12AX7, 2—6AQ5

Dimensions

Recorder in case
Height: 12⅛ inches (approximately) with rubber feet and handle, 10¾ inches less feet and handle
Width: 9½ inches overall, including hinges, 8¾ inches, panel mounting width
Depth: 13⅛ inches overall

Recorder mounted in single panel*
Height: 13$^{3}/_{32}$ inches
Width: 19 inches
Depth: 12¾ inches overall

Recorder mounted in dual panel*
Height: 13$^{3}/_{32}$ inches
Width: 19 inches
Depth: 12$^{7}/_{16}$ inches

Weight
Single G-22A: 39 pounds (including portable case)
Dual-mounted G-22A Recorders: 82 pounds complete
Portable case only: 10 pounds

*See Section 6 for complete details (Accessories Section)

1.6 ACCESSORIES

Accessory equipment includes: optional input chassis; event markers and alarm contacts for both channels; retransmitting potentiometers ganged to the balancing potentiometer shaft; side-by-side pens for zero time displacement between channels; 19-inch rack panel with appropriate panel-mounting cutout, and a special dual mounting case for two Model G-22A recorders, which may be mounted in a 19-inch rack. A test extension chassis is available on order, allowing access to input chassis wiring and test points during operation. Refer to Figure 4-1 illustrating its use.

See Section 6 for accessory details.

description of components

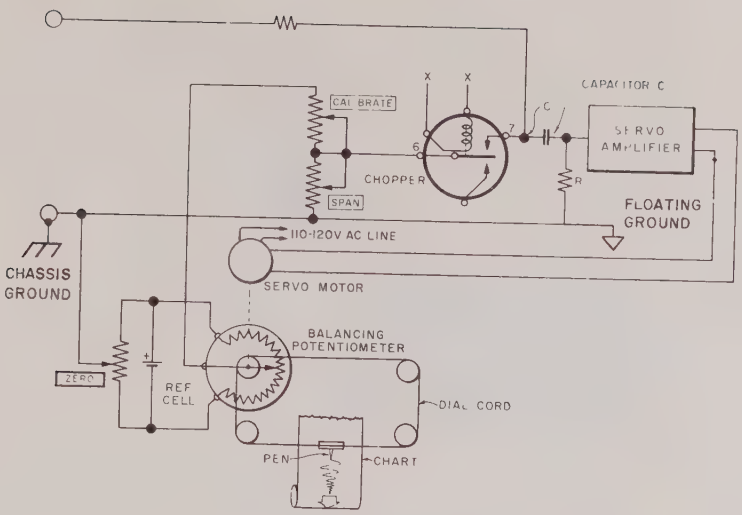


Figure 2-1: Composite Diagram of Model G-22A

2.0 DESCRIPTION OF COMPONENTS

2.1 INTRODUCTION

The plug-in input chassis provides the signal control and adjustment functions of the recorder, plus conversion, attenuation, pre-amplification, and other conditioning of input signals. The main recorder assembly contains the balancing potentiometers, servo systems, servo amplifier sections, power supplies and pen systems for both channels, as well as the chart transport system, chart transport controls, and power controls.

2.2 DESCRIPTION OF SYSTEM OPERATION

The Model G-22A Recorder employs a closed-loop servo system. Through mechanical and electrical components, the input-signal voltage is translated into a proportional physical movement of pen-positioning elements. Figure 2-1 is a composite diagram of the system. Figure 2-2 is a block diagram. A high-resolution, precision potentiometer is used as the electromechanical "translating" element. This is called the balancing potentiometer. Its shaft is attached to the servo motor and to a drum (sheave) around which the pen drive cord is wrapped. The system operates as follows:

A precise measuring voltage derived from a battery or an electronic reference voltage supply is compared to the input signal voltage. This is accomplished at point C of Figure 2-1 by chopper action. The chopper, operating at power-line frequency, has a 50% duty cycle (contacts six and seven are open 50% of the time). During the open period of the chopper cycle, capacitor C charges to the input signal potential. There is no d c current through C due to capacitor current blocking, hence no voltage across R. When chopper contacts six and seven close, however, the measuring voltage sums algebraically with the input signal voltage at point C. If the two voltages are equal and of opposite polarity, null balance is achieved. If they are unequal, the difference voltage, known as the error signal, ap-

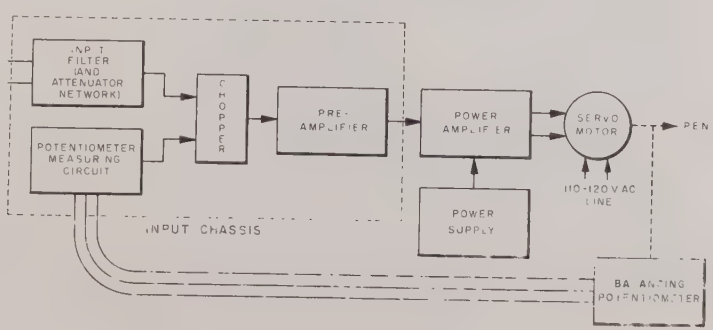


Figure 2-2: Block Diagram of Model G-22A

pears across R as capacitor C charges or discharges. This action occurs at line frequency (the chopper rate). The error signal is then amplified by the servo amplifier and applied to the two-phase servo motor. Direction of servo motor rotation depends on balancing signal phase. The motor rotates the balancing potentiometer shaft, hence the drum (sheave) around which the pen drive cord is wrapped. The direction of rotation is always toward a zero error signal. When this is reached, servo action stops until a change in the input signal occurs. Meanwhile the pen has traced an analogous graph on the chart roll, which has been moved forward at a selected rate by the chart drive system.

2.3 RECORDER COMPONENT UNITS

All items described in Section 2.3 are contained in the main recorder assembly.

2.3.1 Chart Drive System

Figure 2-3 details the chart drive system. The standard Model G-22A is supplied with one chart drive motor, but may be supplied with two motors if desired. Motors are of single-speed, synchronous type with gear-head output. When the Model G-22A Recorder is ordered with two drive motors, motors are selected by the HIGH-LOW-STDBY-OFF switch for high- or low-speed operation. A mechanical gear shifter, the HIGH-N-LOW control, provides an additional four-to-one speed reduction in each motor-speed range, making a total of four different speeds. For chart speeds of 12 inches per minute and above, two motors operating in parallel are required, allowing only two speeds, the basic speed and that obtained through the gear-shifter reduction. In all cases, when basic chart speeds are to be changed, the chart drive motors must be changed.

2.3.2 Pen System

Figure 2-4 details the pen drive systems, methods of coupling pens to balancing-potentiometer sheaves, and shows correct ink cartridge position. Capillary pens, with connection to the ink cartridges by plastic feed tubes, are used. Red ink serves the right-hand input chassis.

2.3.3 Servo Motors

The servo motors are two-phase, reversible induction motors designed for 50/60-Hz operation. Two windings are used. One is excited by the power line, the other, the control winding, by the servo amplifier. The motors are equipped with a mechanical stop to limit pen travel. Because the servo motors are phase sensitive over a limited frequency range, variations in control current at other than line frequency have no effect on operation.

2.3.4 Controls

The Model G-22A main recorder assembly contains the following controls:

HIGH-N-LOW gear shifter—this control provides a four-to-one chart speed reduction between High and Low. N is a neutral position.

HIGH-LOW-STDBY-OFF switch—this switch controls recorder power, and when the recorder is supplied with two chart drive motors, selects the low- or high-speed motor. In STDBY amplifiers are on, and only the control winding of the servo motor is energized. In LOW and HIGH the low- and high-speed chart drive motors, respectively, are operative, and the line winding of the servo motor is energized. If only one chart motor is supplied, it operates in HIGH only.

Figure 2-3: Chart Drive System

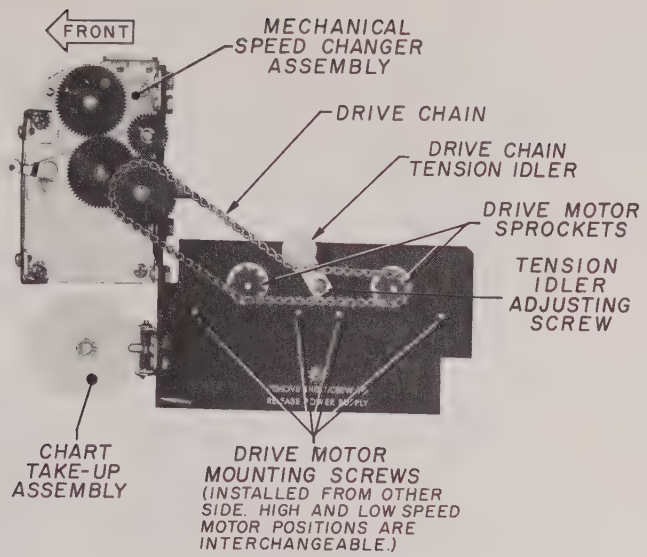
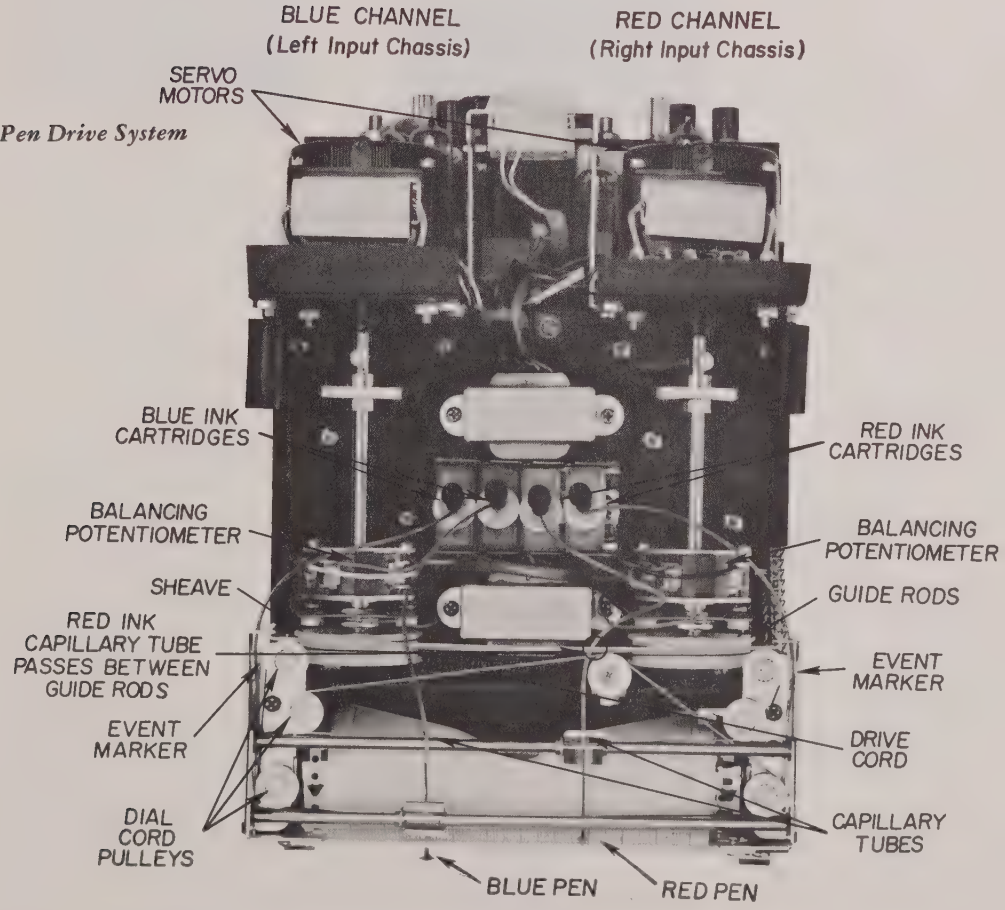

FRONT
MECHANICAL SPEED CHANGER ASSEMBLY
DRIVE CHAIN
DRIVE CHAIN TENSION IDLER
DRIVE MOTOR SPROCKETS
TENSION IDLER ADJUSTING SCREW
CHART TAKE-UP ASSEMBLY
DRIVE MOTOR MOUNTING SCREWS (INSTALLED FROM OTHER SIDE. HIGH AND LOW SPEED MOTOR POSITIONS ARE INTERCHANGEABLE.)

Figure 2-4: Pen Drive System



2.4 POWER SUPPLY AND SERVO AMPLIFIER

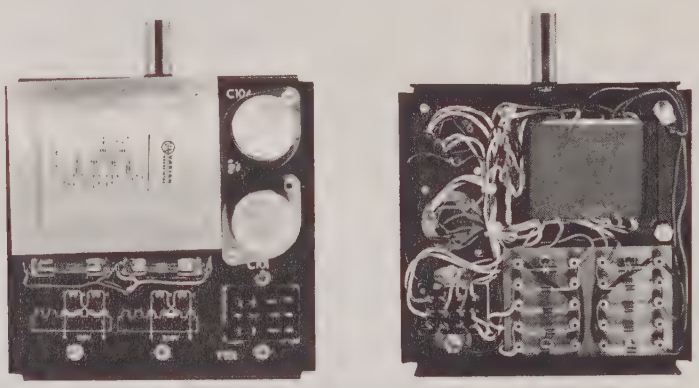
2.4.1 Power Supplies

Two independent power supplies mounted on a common chassis are used. Both utilize silicon rectifiers in a bridge circuit with capacitor-input filtering, and operate from the 115v, 230v, 50 Hz, 60 Hz line through step-up transformers. Use of independent power supplies allows each recording channel to operate simultaneously at different potentials above chassis ground.

2.4.2 Servo Amplifiers

The servo amplifiers are constructed on plug-in printed circuit boards and consist of three amplifying stages, V302A, V302B, and V303. Interstage bandpass networks provide maximum response over a frequency range centered about 50-60 Hz. The error signal is first amplified in the input chassis, then by V302A and V302B in the servo amplifier and last by V303, a beam-power tube which energizes the servo motor control winding through auto transformers T501 or T502.

Figure 2-5: Power Supply



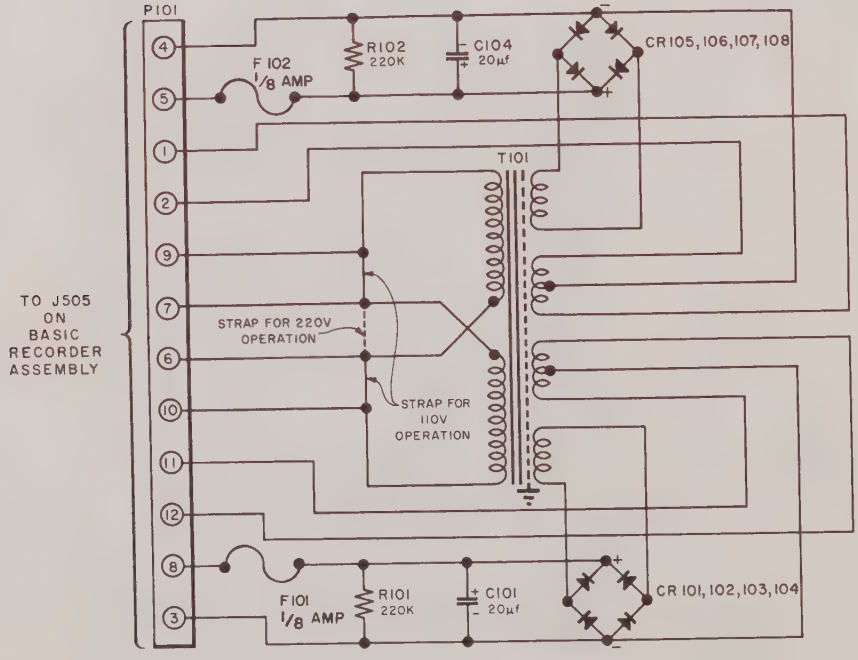


Figure 2-6: Power Supply Schematic

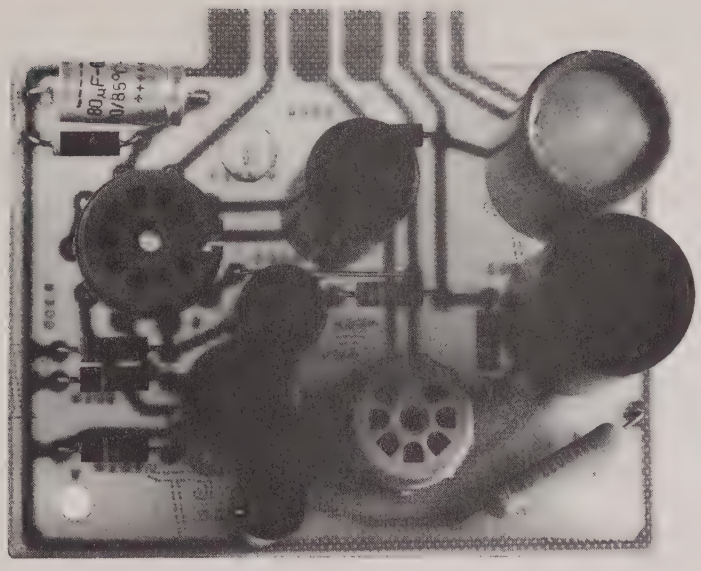
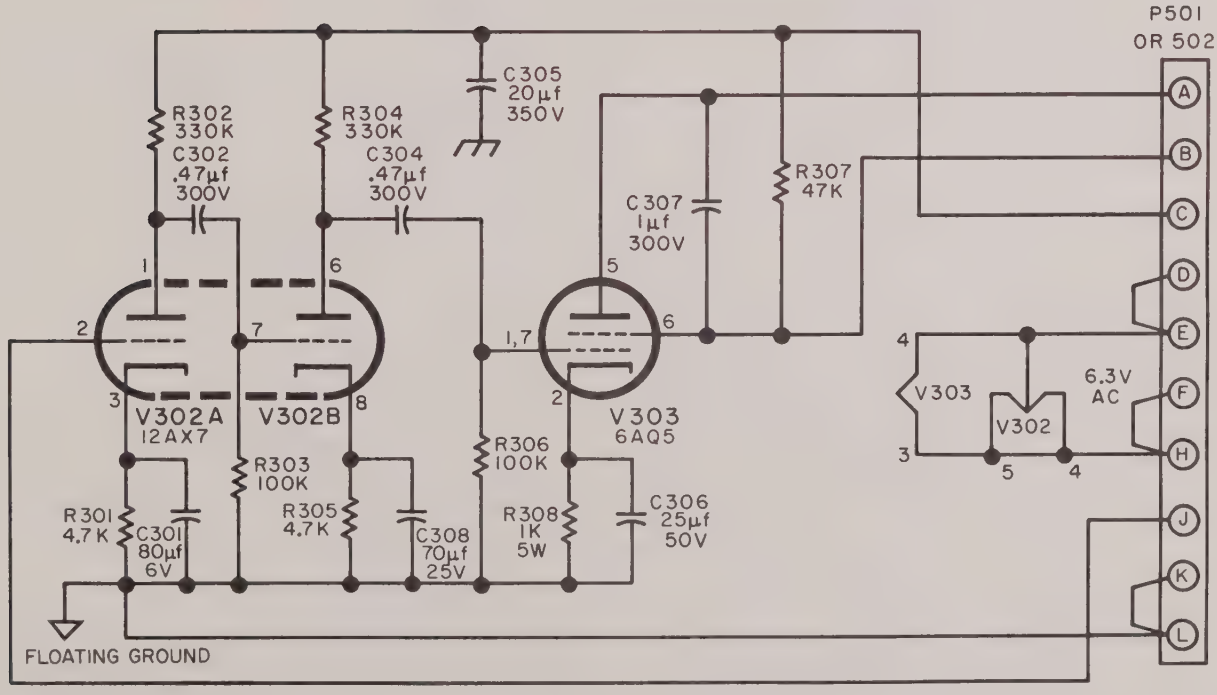


Figure 2-7: Top View Servo Amplifier



NOTES:
1. ALL RESISTORS ARE 1/2 W, 5% UNLESS OTHERWISE SPECIFIED.
2. THIS DWG. IS SCHEMATICALLY EQUIVALENT TO VARIAN DWG. #906054 B.

Figure 2-8: Servo Amplifier Schematic

2.5 TYPE A-21A INPUT CHASSIS

The Type A-21A Input Chassis contains adjustments which permit the recording of input signals from 5 mv to 100 mv with full-span pen deflection. The Type A-21A uses a mercury cell as the reference voltage source.

2.5.1 A-21A Input Chassis Specifications

Polarity
Positive-going signals cause left-to-right pen travel

Balancing Time
0.6 second with full-span step input

Limit of Error
±1.0% of span

Sensitivity
0.25% of span

Pen Speed
1 second full scale

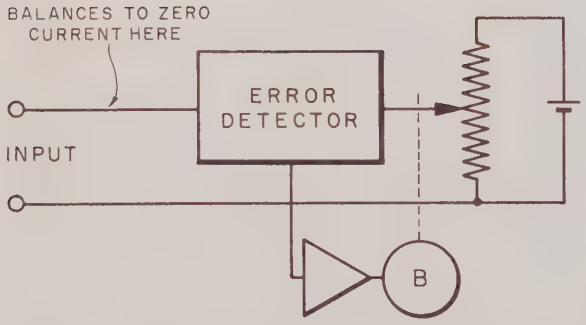
Span
Continuously adjustable 5 to 100 mv

Maximum Allowable Source Resistance
50K ohms at 5 mv span, 100K ohms at 100 mv span

Voltage Reference
1.34 volt mercury cell

Input
Isolated from ground but not balanced. Two channels are electrically independent and each input signal may be floated above ground by as much as 200 volts.

Tube Complements
12AX7 used for all spans.



A-21A ALL SPAN RANGES

Figure 2-9: A-21A Equivalent Input Circuit

2.5.2 Description of A-21A Circuit

The Type A-21A Input Chassis contains a low-pass input filter, an isolation network, a two-stage amplifier, a chopper, and a reference circuit. The input signal appears at C206 when chopper contacts 6 and 7 are open. When these contacts are closed, the reference voltage appears across R217, R214, and R216 summing with the input signal at C206. If the two voltages differ, C206 charges or discharges, and an error signal appears across R224. This signal is then amplified and applied to the servo amplifier.

2.5.3 A-21A Controls and Adjustments

ZERO Control

The front panel ZERO control, R215 is shown in the accompanying schematic. This control shifts the zero-voltage point along the balancing potentiometer slidewire, hence the zero position of the pen. It is usually adjusted so the pen is at the zero point on the chart with no signal output, but may also be used to adjust the pen for zero center operation, or any desired zero point on the chart.

Damping

Note that damping is not a manual adjustment. Damping is electrically fixed and should not be confused with manual controls.

As the servo motor turns the balancing potentiometer toward zero error position, system inertia causes the servo motor and potentiometer to overshoot the zero error position. Capacitor C213 provides a fixed damping constant to overcome this tendency, by creating a condition in which current leads voltage, the amount of current lead being sufficient to create an "apparent null" before null is actually reached.

CALIBRATE Control

The front panel CALIBRATE control, R216, provides a fine, series adjustment of the voltage from the reference source to compensate for the slight decay of mercury cell voltage with time, and to provide a fine span adjust.

SPAN Control

The front-panel SPAN control, R217, adjusts the amplitude of the measuring voltage appearing at the chopper contact, therefore determining the maximum input signal which can be properly nulled.

GAIN Control

When span is changed to accommodate signals of different full-scale amplitude, the resulting balancing signal has a correspondingly different amplitude. By means of the rear-access GAIN control R232, the balancing signal may be adjusted to the level required.

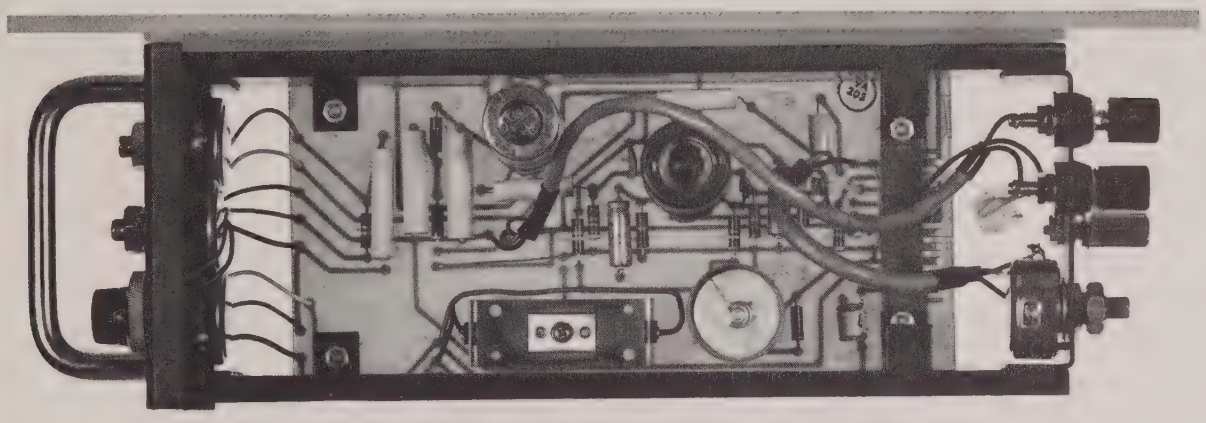


Figure 2-10: A-21A Input Chassis

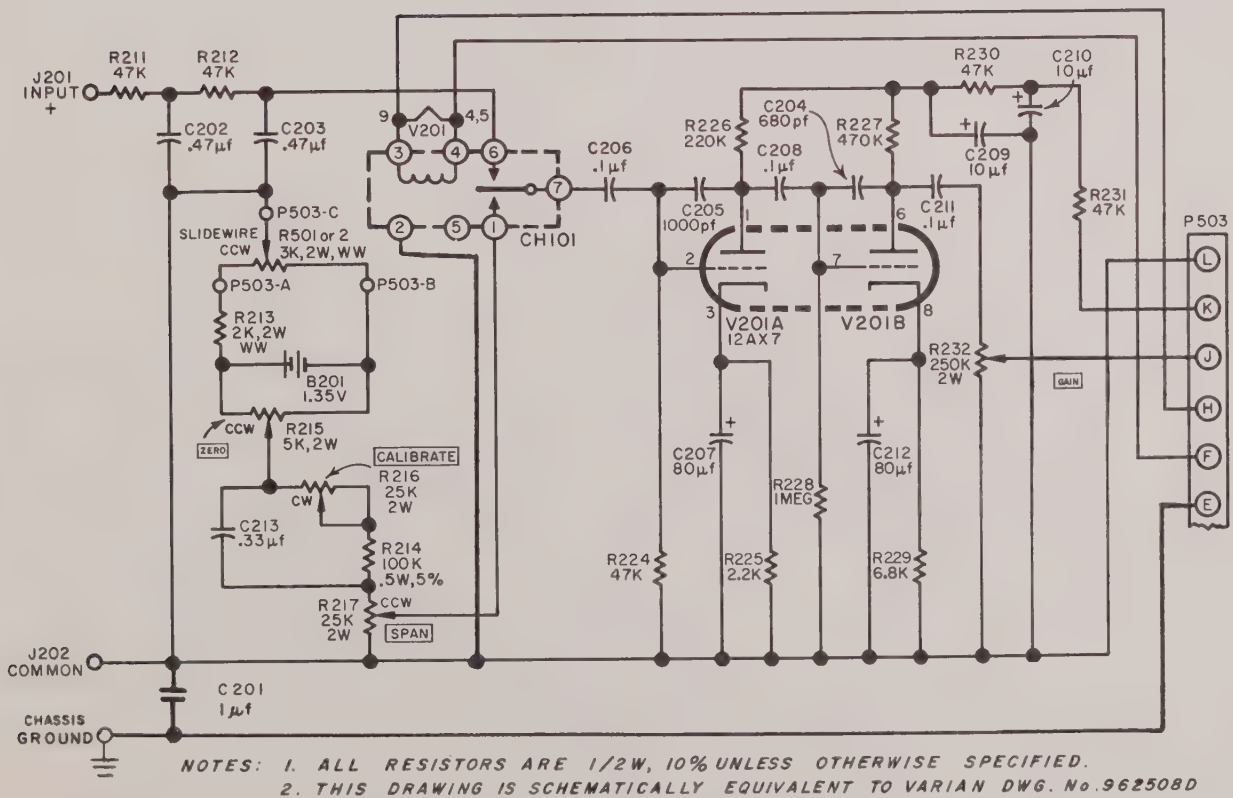


Figure 2-11: A-21A Input Chassis Schematic

2.6 TYPE A-22A INPUT CHASSIS

The Type A-22A Input Chassis contains adjustments which permit the recording of input signals from 5 mv to 100 mv with full-span pen deflection, and uses a Zener diode electronic circuit for voltage reference.

2.6.1 A-22A Input Chassis Specifications

Polarity
Positive-going signals cause left-to-right pen travel

Balancing Time
0.6 second with full-span step input

Limit of Error
±1.0% of span

Sensitivity
0.25% of span

Pen Speed
1 second full scale

Span
Continuously adjustable 5 to 100 mv

Maximum Allowable Source Resistance
50K ohms at 5 mv span, 100K ohms at 100 mv span

Voltage Reference
Zener diode electronic circuit

Input
Isolated from ground but not balanced. Two channels are electrically independent and each input signal may be floated above ground by as much as 200 volts.

Tube Complement
12AX7 used for all spans.

2.6.2 Type A-22A Circuit Description

The Type A-22A Input Chassis contains a low-pass input filter, an isolation network, a two-stage amplifier, a chopper, and reference circuit. The input signal appears at C206 when chopper contacts 6 and 7 are open. When these contacts are closed, the reference voltage appears across R217, R214, and R216 summing with the input signals at C206. If the two voltages differ, C206 charges or discharges, and an error signal appears across R224. This signal is then amplified and applied to the servo amplifier.

2.6.3 Type A-22A Controls and Adjustments

The Type A-22A Input Chassis contains the following controls:

ZERO Control

The ZERO control, R215, is shown in the accompanying schematic. This front panel control shifts the zero-voltage point along the balancing potentiometer slidewire, hence the zero position of the pen. It is usually adjusted so the pen is at the zero point on the chart with no signal input, but may also be used to adjust the pen for zero center operation, or any desired zero point on the chart.

Damping

Note that damping is not a manual adjustment. Damping is electrically fixed and should not be confused with manual controls.

As the servo motor turns the balancing potentiometer toward zero error position, system inertia causes the servo motor and potentiometer to overshoot the zero error position. Capacitor C213 provides a fixed damping constant to overcome this tendency, by creating a condition in which current leads voltage, the amount of current lead being sufficient to create an "apparent null" before null is actually reached.

CALIBRATE Control

The front panel CALIBRATE control, R216, provides a fine, series adjustment of the voltage from the reference source. It also provides a fine span adjustment.

SPAN Control

The front-panel SPAN control, R217, adjusts the amplitude of the measuring voltage appearing at the chopper contact, therefore determining the maximum input signal which can be properly nulled.

GAIN Control

When span is changed to accommodate signals of different full-scale amplitude, the resulting balancing signal has a correspondingly different amplitude. By means of the rear-access GAIN control R232, the balancing signal may be adjusted to the level required.

2.6.4 Electronic Reference Circuit Description

The electronic reference voltage supply is constructed on a separate printed circuit board. The unit includes a transformer, a bridge rectifier, a filter and a Zener diode voltage regulator used in a bridge arrangement. Resistance values are chosen to form a balanced bridge which includes the dynamic resistance of the Zener diode. Variable resistor, R404, is adjusted at the factory so that the diode bridge will match the dynamic resistances of individual diodes. Such an arrangement provides excellent regulation of the reference voltage with line-voltage variations. The use of an electronic reference voltage supply eliminates the necessity of periodically changing the mercury reference cell, and correcting for the decay of cell voltage.

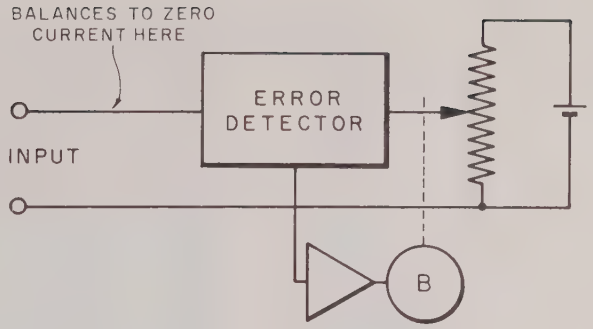


Figure 2-12: A-22A Equivalent Input Circuit

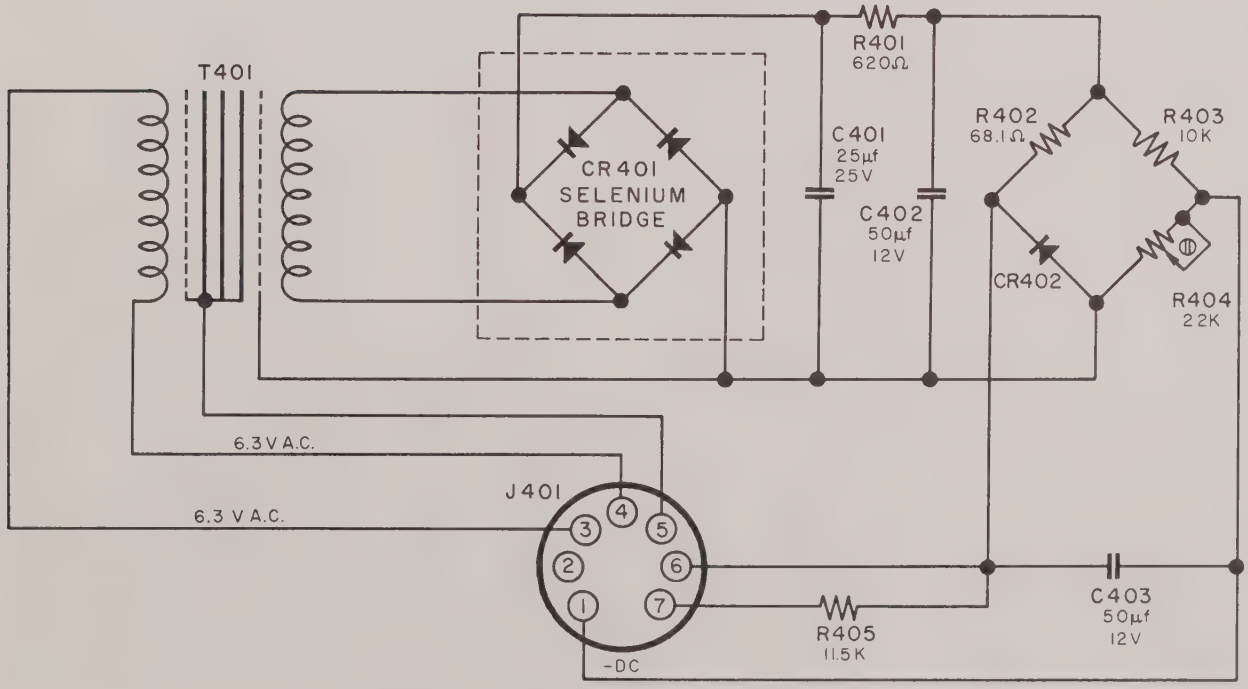


Figure 2-13: Electronic Reference Supply Schematic

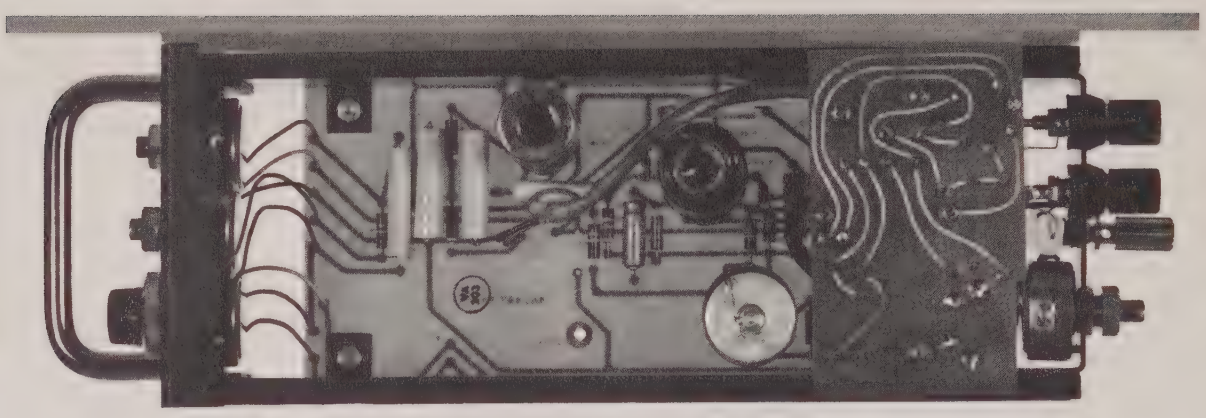
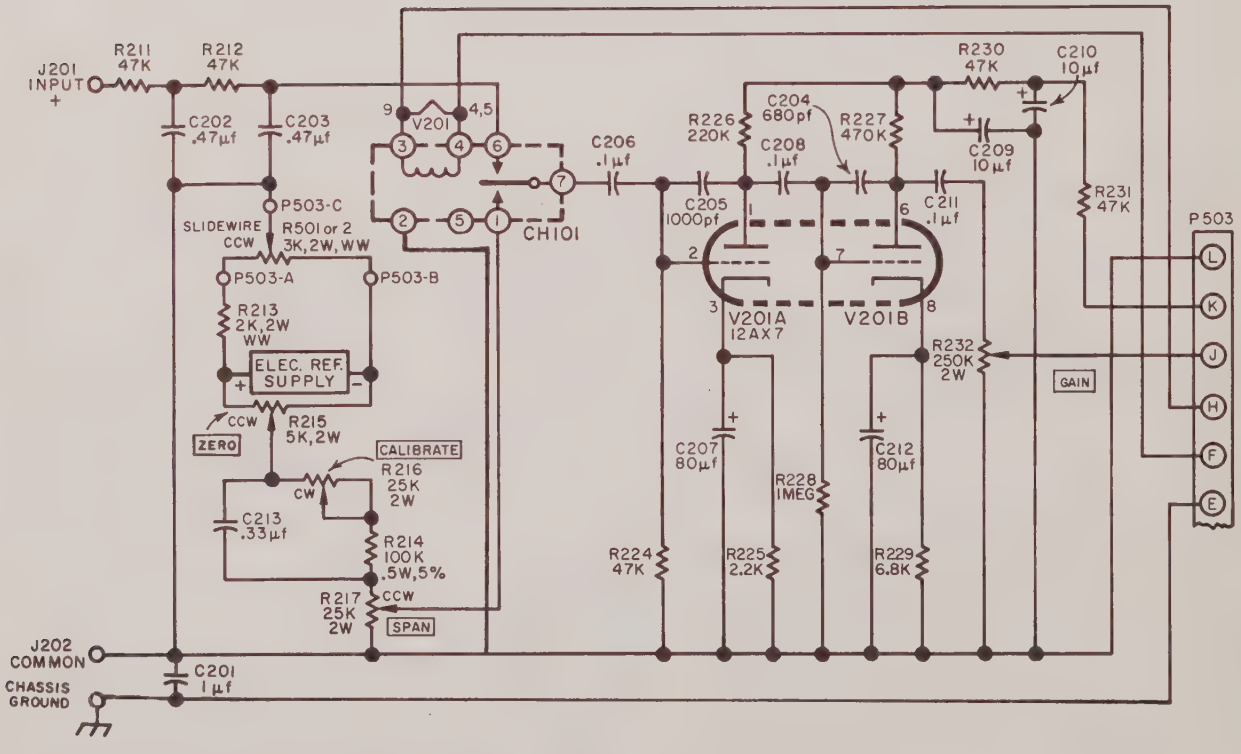


Figure 2-14: A-22A Input Chassis



NOTES:

1. ALL RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE SPECIFIED.
2. THIS DWG. IS SCHEMATICALLY EQUIVALENT TO VARIAN DWG. # 962567 C

Figure 2-15: A-22A Input Chassis Schematic

2.7 TYPE B-22A WIDE RANGE INPUT CHASSIS

The Type B-22A Input Chassis contains the basic circuitry of the Type A-22A Input Chassis including the electronic reference voltage supply. The attenuator or VOLTS switch and the range vernier allow the recording of voltages from 10 mv to 500 v with full-span deflection. These controls are described below.

2.7.1 Type B-22A Input Chassis Specifications

Limit of Error
±1.0% of span on 10-mv setting
±2.0% of span on all other ranges

Sensitivity
0.25% of span

Span
Continuously adjustable from 10 mv to 500 volts. Spans of 10, 20, 50, 100, 200, 500 mv and 1, 10, 100 volts selected by front-panel gang switch. Uncalibrated vernier control allows continuous span adjustment between fixed ranges and up to 500 volts.

Input Resistance
10-mv span: Standard potentiometer input, with resistance approaching infinity at balance and greater than ½ megohm off balance.

20-, 50-, 100-, 200, 500-mv spans	0.1 megohm
1-volt span	0.1 megohm
10-volt span	1 megohm
100-volt span	10 megohms

Maximum Permissible Source Resistance
50K ohms at 10 mv span. No limitation imposed by recorder at other spans. See input resistances above for possible effect on source.

Reference System
Zener diode electronic circuit

Input
Isolated from ground, but not balanced. The two channels are electrically independent and each input signal may be floated above ground by as much as 200 volts.

Voltage Range
Zero to 500 vdc, continuous, for full-span deflection

Polarity
Positive-going signals cause left-to-right pen travel

Tube Complement
1—12AX7

2.7.2 Type B-22A Circuit Description

The input network of the Type B-22A contains an adjustable attenuator circuit. The attenuator or VOLTS switch, S201, selects the recording range and is calibrated in nine full-scale signal amplitudes. In the one-volt range, a one-volt input signal will produce full-span pen deflection, etc.

The input resistance of the Type B-22A Input Chassis in the 10 mv range of the attenuator switch, with the range vernier in CALIBRATE, is greater than 0.5 megohm off null, approaching infinity at null. At other settings of the attenuator switch, the measured source will be loaded with the resistance of the divider circuit, whether on or off null.

2.7.3 Type B-22A Controls and Adjustments

ZERO Control

The front panel ZERO control, R215, shifts the zero voltage point along the balancing potentiometer slidewire, hence the zero position of the pen. It is usually adjusted so that the pen is at the zero point on the chart with zero signal input, but may also be used to adjust the pen for zero center operation, or any desired zero point on the chart.

Damping

Note that damping is not a manual adjustment. Damping is electrically fixed and should not be confused with manual controls.

As the servo motor turns the balancing potentiometer toward zero error position, system inertia causes the servo motor and potentiometer to overshoot the zero error position. Capacitor C213 provides a fixed damping constant to overcome this tendency, by creating a condition in which current leads voltage, the amount of current lead being sufficient to create an "apparent null" before null is actually reached.

CALIBRATE Control

The front panel CALIBRATE control, R218, provides a fine series adjustment of the voltage from the reference supply to accomplish accurate calibration.

Range Vernier Control

An important feature of the Type B-22A Input Chassis is the range vernier, R210. This front panel control provides attenuation additional to that of the attenuator switch, S201. In order to obtain full-span pen deflection for the indicated full scale ranges of the attenuator VOLTS switch, the range vernier must be in the CALIBRATE position, which removes it from the circuit. The range vernier allows a continuous span adjustment from approximately 10mv to the maximum value of the selected attenuator switch range setting, and spans up to 500 volts in the 100-volt attenuator switch range.

GAIN Control

When span is changed to accommodate signals of different full-scale amplitude, the resulting balancing signal has a correspondingly different amplitude. By

means of the rear-access GAIN control, R232, the balancing signal may be adjusted to the level required for optimum system performance.

2.7.4 Electronic Reference Circuit Description

The electronic reference voltage supply is constructed on a separate printed circuit board. The unit includes a transformer, a bridge rectifier, a filter and a zener-diode voltage regulator used in a bridge arrangement. Resistance values are chosen to form a balanced bridge which includes the dynamic resistance of the Zener diode. R404 is a variable resistor adjusted at the factory so that the diode bridge will match the dynamic resistances of individual diodes. Such an arrangement provides excellent regulation of the reference voltage with line-voltage variations. The use of an electronic reference voltage supply eliminates the necessity of periodically changing the mercury reference cell, and correcting for the decay of cell voltage.

2.7.5 Type B-22A Special Operating Notes

To use the range vernier and attenuator switch, proceed as follows:

a) Set the attenuator or VOLTS switch to the nearest span range below the voltage of the signal to be measured.

b) Set the range vernier with the pointer on the knob pointing straight up.

c) Apply the full scale signal to be measured, adjusting the range vernier for full-span pen deflection. The recorder is now calibrated to give full-span deflection for the selected voltage.

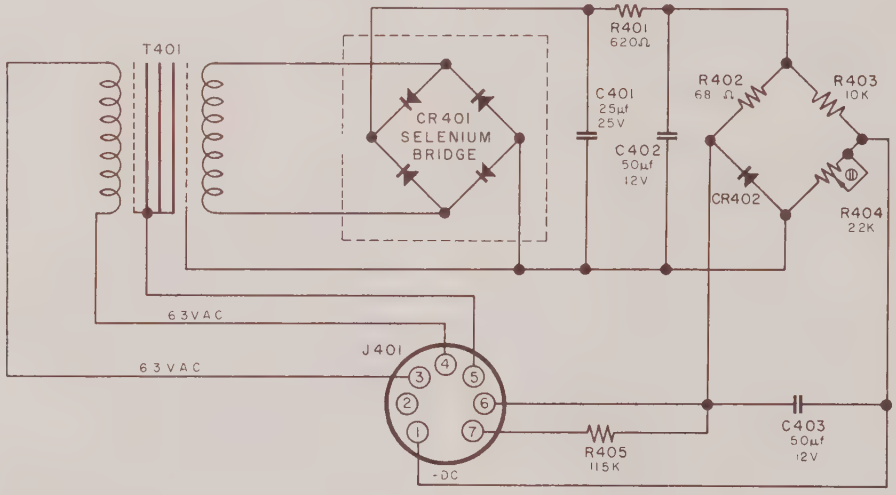


Figure 2-16: Electronic Reference Supply Schematic

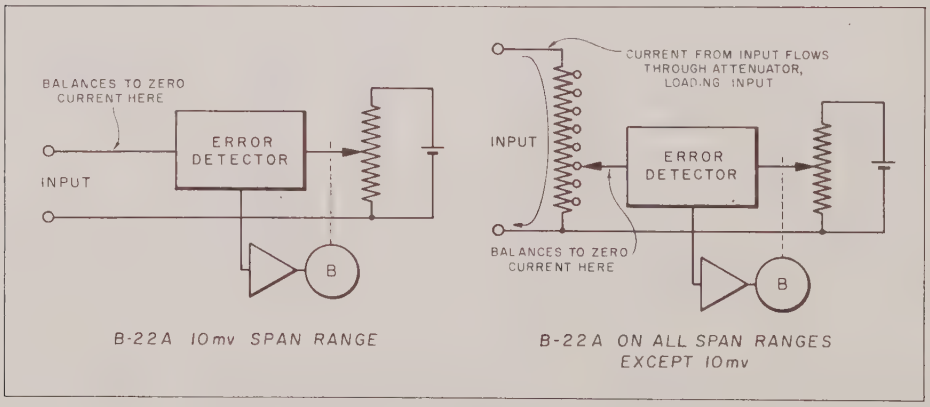


Figure 2-17: B-22A Equivalent Input Circuit

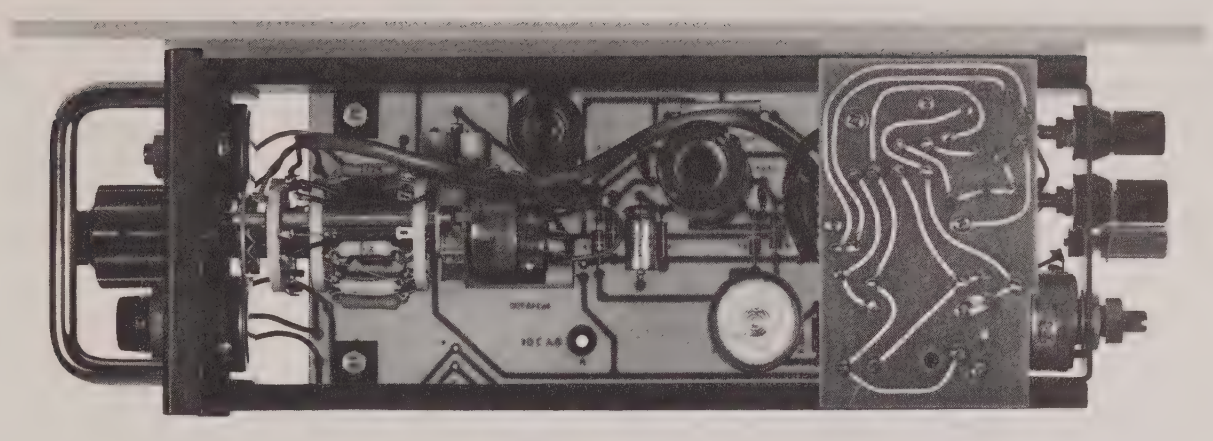
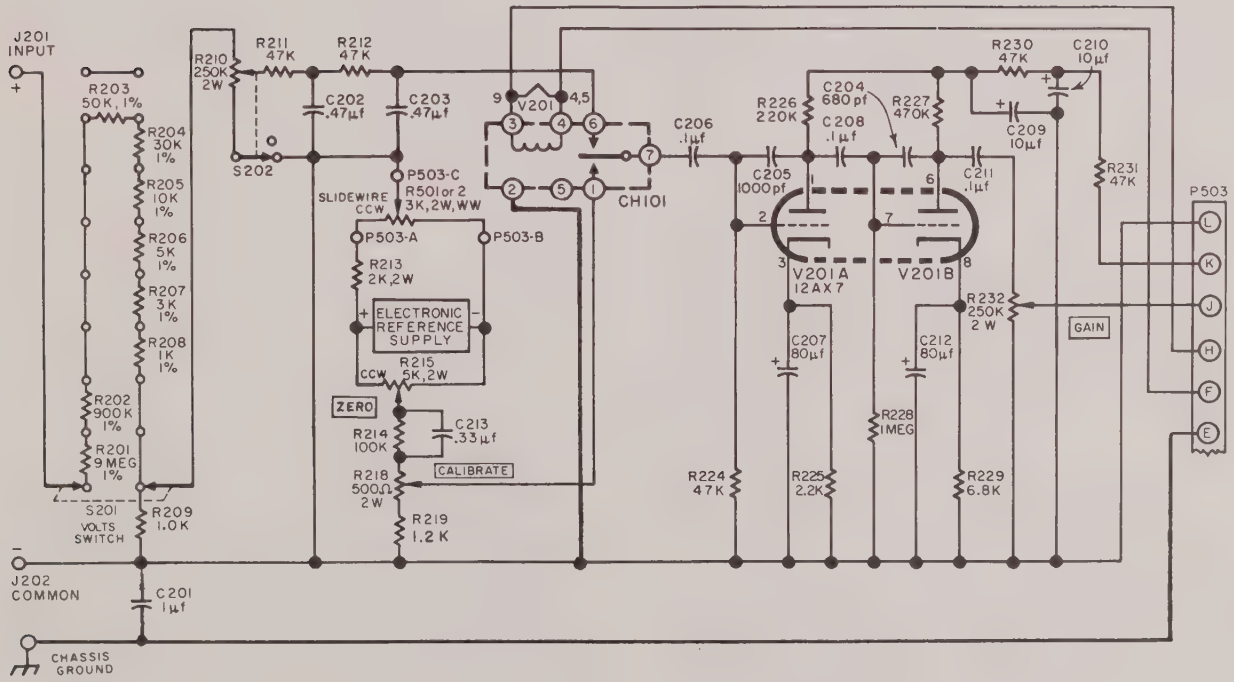


Figure 2-18: B-22A Input Chassis



NOTES:

1. THIS DWG. IS SCHEMATICALLY EQUIVALENT TO VARIAN DWG. # 962596 E

Figure 2-19: B22A Input Chassis Schematic

2.8 TYPE T-22A THERMOCOUPLE INPUT CHASSIS

The Type T-22A Thermocouple Input Chassis is a modular, plug-in unit which permits the Model G-22A Dual Channel Recorder to be used in temperature recording applications. The T-22A provides suitable conditioning and pre-amplification of signals generated by the various thermocouple types which may be used with it. Variations in temperature at the reference junction will introduce undesired voltage variations in the output of the thermocouple, because the temperature-responsive voltage generated by a thermocouple is proportional to the temperature difference between the measuring junction and the reference junction. The T-22A Input Chassis offers a method* of accurate and automatic reference-junction temperature compensation. Temperatures may be recorded within 1% of span for ambient changes at the reference junction over the range of 0°C to 40°C, the recommended operating ambient of the G-22A Recorder. The Type T-22A Input Chassis is fully compatible electrically and physically with the main recorder assembly.

Most thermocouple types may be used with the T-22A Input Chassis. Change of temperature range requires a change of the chart paper and recorder scale, while change of thermocouple type requires a change of the thermocouple board as well. These items are available in calibrations for the temperature ranges listed in Table II. Thermocouple boards contain resistor networks to adjust the circuit for thermocouple output-voltage slope and temperature ranges. The thermocouple boards are readily interchangeable. Special thermocouple boards, chart paper, and scales can be supplied on order.

Automatic thermocouple reference junction compensation is provided by the T-22A circuit, as well as a continuous electronic reference voltage for the instrument's potentiometer measuring circuit.

Three front panel controls allow continuous adjustment of the temperature span over the practical working range of most common thermocouple types. No components need be added or replaced in order to establish a different span, provided the same type of thermocouple is used as the sensing element. To use another thermocouple type merely requires replacing the small compensation card (thermocouple board) located in the plug-in T-22A Chassis.

* Patent applied for

2.8.1 Type T-22A Input Chassis Specifications

Charts and Scales
Available from stock for all ranges listed in Table II. Those in Table III can be supplied on special order.

Span
Continuously adjustable within the limits indicated in Table II.

Limit of Error
±1% of span (using specified chart paper)

Sensitivity
0.25% of span

Pen Speed
0.6 second full scale

Input Circuit
Potentiometric, isolated from ground but not balanced

Thermocouple Reference Junction Compensation
Replaceable circuit card provides automatic compensation for changes in reference junction temperature for the particular type of thermocouple used. Leads made of appropriate thermocouple materials (except on cards for platinum-rhodium thermocouples where copper leads are used) form reference junction embedded directly within compensating element. Sensing thermocouple makes direct connection with compensator leads at external binding posts.

Voltage Reference
Zener diode electronic circuit

Range of Automatic Reference Junction Compensation
0°C to 40°C (ambient operation range of G-22A Recorder)

Tube Complement
1—12AX7

2.8.2 Type T-22A Controls and Adjustments

ZERO ADJUST Controls

These front panel controls, COARSE, R236, and FINE, R242, are used to position the recorder pen at a selected reference point located at the low end of the recorded temperature range. (For example, 0°C or 32°F.)

GAIN Control

The rear-access GAIN control, R232, controls the signal output to the servo amplifier. Re-adjustment of this control may be necessary if the input chassis tube is changed.

SPAN Control

The front panel SPAN control, R235, adjusts the amplitude of the measuring voltage appearing at the chopper contact, therefore determining the maximum input signal to the recorder which can be properly nulled.

2.8.3 T-22A Thermocouple Compensating Board

Variations in temperature at the reference junction will introduce undesired voltage variations in the output

of the thermocouple, because the temperature-responsive voltage generated by a thermocouple is proportional to the temperature difference between the measuring junction and the reference junction. Provided the same type of thermocouple is used as the sensing element, no components need be added or replaced in order to establish a different span. When malfunction is evident or suspected, the thermocouple compensating board should be returned to the factory for repair or replacement as necessary.

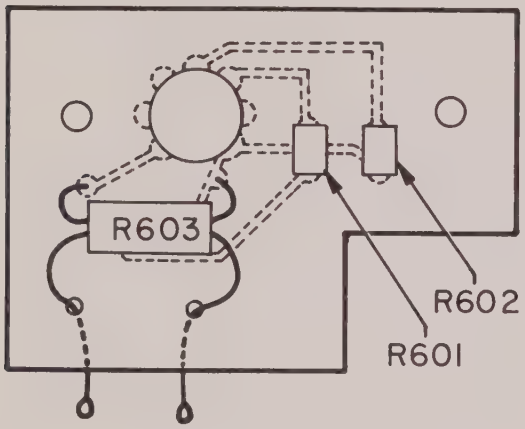


Figure 2-20
T-22A Thermocouple Compensating Board

2.8.4 Type T-22A Operating Instructions

(1) Insert proper thermocouple board into the T-22A Input Chassis.

(2) Plug T-22A Input Chassis into G-22A Recorder. Install proper chart and recorder scale for thermocouple used and temperature range to be recorded.

(3) With scale fastening screws loosened, position scale laterally so that recorder pen and pointer align with corresponding chart and scale calibrations, respectively. Tighten scale mounting screws.

(4) Connect G-22A Recorder to power line. Turn HIGH-LOW-STDBY-OFF switch to STDBY.

(5) Connect thermocouple to T-22A Input Chassis at J201 and J202 input terminals, observing correct polarity. To record, place the HIGH-LOW-STDBY-OFF switch in HIGH or LOW as required.

NOTE

Positions of T-22A Input Chassis in the recorder cannot be interchanged without recalibration.

2.8.5 Type T-22A Chassis Calibration Procedure

On T-22A Input Chassis R235 is designated SPAN. R236 is designated COARSE ZERO ADJUST and R242 is designated FINE ZERO ADJUST.

(1) Short circuit the input terminals.

(2) Adjust the SPAN control until the recorder indicates ambient temperature.

(3) Apply a known EMF equivalent to the maximum span desired, less ambient temperature.

(4) Adjust coarse and fine zero controls.

NOTE

On T-22A Input Chassis with serial number below 161, R235 is designated SPAN, and R236A, R236B are designated ZERO.

2.8.6 Type T-22A Thermocouple Calibration Procedure

The T-22A Input Chassis has been accurately calibrated at the factory. The unit does not require recalibration when thermocouple compensating boards and thermocouples are exchanged, nor do any of its controls require readjustment. However, if the T-22A has been in operation for considerable time and recordings of high reliability are required, a calibration check may be desirable due to aging of components. Check performance before attempting to adjust any of the controls. As a rule, it is best not to tamper with the adjustments of this input chassis unless calibration and adjustment are absolutely necessary.

To duplicate factory calibration accuracy in the field requires careful execution of the following steps:

(1) Prepare an ice-water bath in a thermos or Dewar container. Use distilled water and ice made from distilled water, otherwise the temperature of the bath may not be accurate enough for calibration purposes. The ice must be melting.

(2) Proceed with the steps of Section 2.8.4.

(3) With the HIGH - LOW - STDBY - OFF switch in HIGH, immerse thermocouple measuring junction in the ice-water bath.

(4) After immersion of the thermocouple measuring junction for approximately five minutes, adjust the SPAN control until the recording pen rests at the O°C or 32°F point of the chart. (For suppressed zero operation, see Section 2.8.6.1).

(5) Refer to Figure 2-23, Calibration Voltage Source. Break the positive thermocouple lead, and fasten the part attached to the measuring junction to the positive terminal of the calibration voltage source, and the remaining part from the negative terminal of the calibration voltage source to the positive terminal of the T-22A Input Chassis. Connect the negative thermocouple lead to the negative terminal of the T-22A Input Chassis.

NOTE

Make sure that the two terminals of the calibration voltage source are at the same temperature. When using iron-constantan thermocouples, the iron thermocouple lead (positive) may be broken and attached to the calibration voltage source through two ten-inch lengths of copper wire, rather than attaching it directly as above. Keep the junction points with the two connecting wires from contacting any surface. In this way the junction points will remain approximately at room temperature. The exact temperature is unimportant, so long as it is the same at both points.

(6) Refer to NBS Circular 561 [see para. 2.8.6.1 (3)]. Adjust the output of the calibration voltage source until full-span pen deflection occurs. The voltage across the T-22A input terminals should be within 1% of the voltages listed, as applicable. If not, adjust the FINE ZERO ADJUST control and the calibration voltage source until full-span pen deflection occurs at the specified voltage for the thermocouple board being used.

(7) Strap the calibration voltage source terminals together and repeat step (4) above. If either full-scale or zero calibration cannot be achieved, check the following:

1. Chart paper (for correct type)
2. Thermocouple type
3. Thermocouple lead polarity
4. Thermocouple
5. Calibration voltage
6. Balancing potentiometer phasing
7. Recorder gain

NOTE

It is possible that minor difficulties may be experienced when attempting to use a new T-22A Input Chassis with a G-22A Recorder that has been in use for some time. In such cases, check the list of possible causes above. The trouble can invariably be eliminated by so doing. Do not attempt to recalibrate the input chassis as a first step toward locating and eliminating troubles. Recalibration should always be a final step after a thorough check of operation indicates that it is necessary.

(8) Secure all adjustment locking nuts.

2.8.6.1 Suppressed Zero Calibration

In suppressed-zero operation, the lower scale limit, or left-hand margin of the chart, is calibrated at some point above 0°C or 32°F. Suppressed-zero charts and thermocouple compensating boards are often supplied on order. These steps are also applicable to any recording application in which 0°C or 32°F is off the scale, whether above the upper scale limit or below the lower scale limit.

(1) Perform steps (1), (2), and (3) of Section 2.8.6. An ice-water bath is used to provide an accurate reference temperature.

(2) Attach the thermocouple positive and negative leads as outlined in step (5) of Section 2.8.6 to a suitable calibration voltage source. Adjust the output of this source so that the pen rests at the left-hand margin of the chart (without having made any adjustments to the T-22A Input Chassis itself).

(3) Refer to United States Department of Commerce NBS Circular 561, entitled "Reference Tables for Thermocouples", issued April 27, 1955. This document contains tables of output voltage versus temperature and other data for generally used thermocouple types in the United States. Refer to the section applicable to the particular thermocouple being used. Note the listed thermocouple output voltage corresponding to the lower scale temperature. Supply the proper voltage across the T-22A Input Chassis input terminals, and adjust the calibration voltage source until this voltage equals the listed voltage.

(4) Adjust the SPAN control until the pen rests at the lower-scale temperature mark.

(5) Repeat the same procedure for establishing the upper scale maximum as is covered in step (3) above, adjusting the output voltage of the calibration voltage source so that the voltage across the T-22A input terminals equals the listed thermocouple output voltage for the upper scale temperature.

(6) Adjust the FINE ZERO ADJUST control until the pen rests at the correct upper scale limit.

(7) Secure all adjustment locking nuts.

TABLE I
EXAMPLE OF POSSIBLE T-22A TEMPERATURE SPAN SETTING

	TEMPERATURE	THERMOCOUPLE OUTPUT VOLTAGE
Upper Limit	700°C	39.15 mv
Lower Limit	500°C	27.39 mv
Span (difference)	200°C	11.76 mv (Difference must be 5 mv or more.)

Based on Iron-Constantan thermocouple with cold junction at 0°C.
Reference: National Bureau of Standards Circular 561.

TABLE II
STANDARD TEMPERATURE RANGES

With charts and indicating scales

RANGE		THERMOCOUPLE	THERMOCOUPLE	CHART TYPE		
Fahrenheit	Centigrade	TYPE	BOARD	°F	°C	SCALE NO.
0° to 400°	—20° to 200°	Iron-Constantan	01	101A	201A	101-201
0° to 600°	—20° to 300°	Iron-Constantan	01	102A	202A	102-202
0° to 750°	—20° to 400°	Iron-Constantan	01	103A	203A	103-203
0° to 1100°	—20° to 600°	Iron-Constantan	01	104A	204A	104-204
0° to 2200°	—20° to 1200°	Chromel-Alumel	02	106A	206A	106-206
—150° to 250°	—100° to 120°	Copper-Constantan	03	107A	207A	107-207
	—200° to 50°	Copper-Constantan	03		208A	208
30° to 220°	0° to 100°	Iron-Constantan	01	109A	209A	109-209
30° to 2750°	0° to 1500°	Platinum-Platinum 13% Rhodium	04	110A	210A	110-210

Other Temperature Span Settings

In addition to being calibrated for the standard ranges listed in Table II the T-22A chassis may be factory-set, or field-calibrated, for any temperature span within the limits listed in Table III below. Span settings may be as broad as the maximum range indicated, or as narrow as the approximate figures given for minimum span*. Ranges of measurement beginning at elevated temperatures ("suppressed zero") may also be accommodated. See the example below.

TABLE III
LIMITS OF CALIBRATION

TYPE OF THERMOCOUPLE	THERMOCOUPLE COMPENSATION CARD NO.	MAXIMUM RANGE OF MEASUREMENT °F	MAXIMUM RANGE OF MEASUREMENT °C	MINIMUM SPAN* (APPROXIMATE) °F	MINIMUM SPAN* (APPROXIMATE) °C
Iron-Constantan, type J	01	0° to 1400°	—20° to 760°	175°	100°
Chromel-Alumel, type K	02	0° to 2500°	—20° to 1370°	260°	145°
Copper-Constantan, type T	03	—325° to 750°	—200° to 400°	335°	185°
Platinum-Platinum 13% Rhodium, type R	04	30° to 3100°	0° to 1700°	1020°	550°
Platinum-Platinum 10% Rhodium, type S	05	30° to 3215°	0° to 1765°	1070°	580°
Other types	—— Contact factory ——				

* *Due to the intrinsic non-linearity of thermocouples, the minimum possible temperature span attainable with the T-22A chassis will actually depend on where the upper and lower temperature limits fall within the thermocouple's overall operating range. In many cases the minimum span may be even smaller than the figure shown above. The limiting factor is that the difference between the thermocouple output voltage (emf) at the two end points of the desired range must be no less than approximately 5 millivolts.*

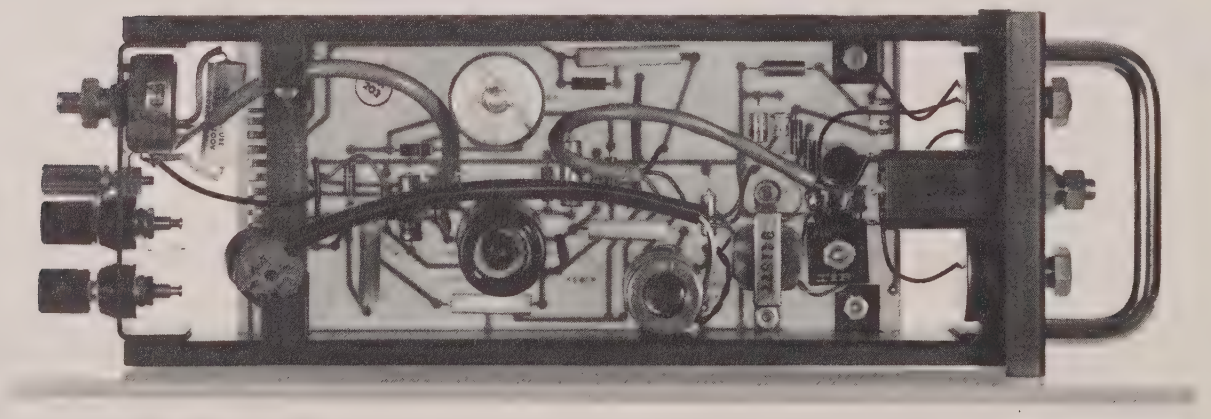
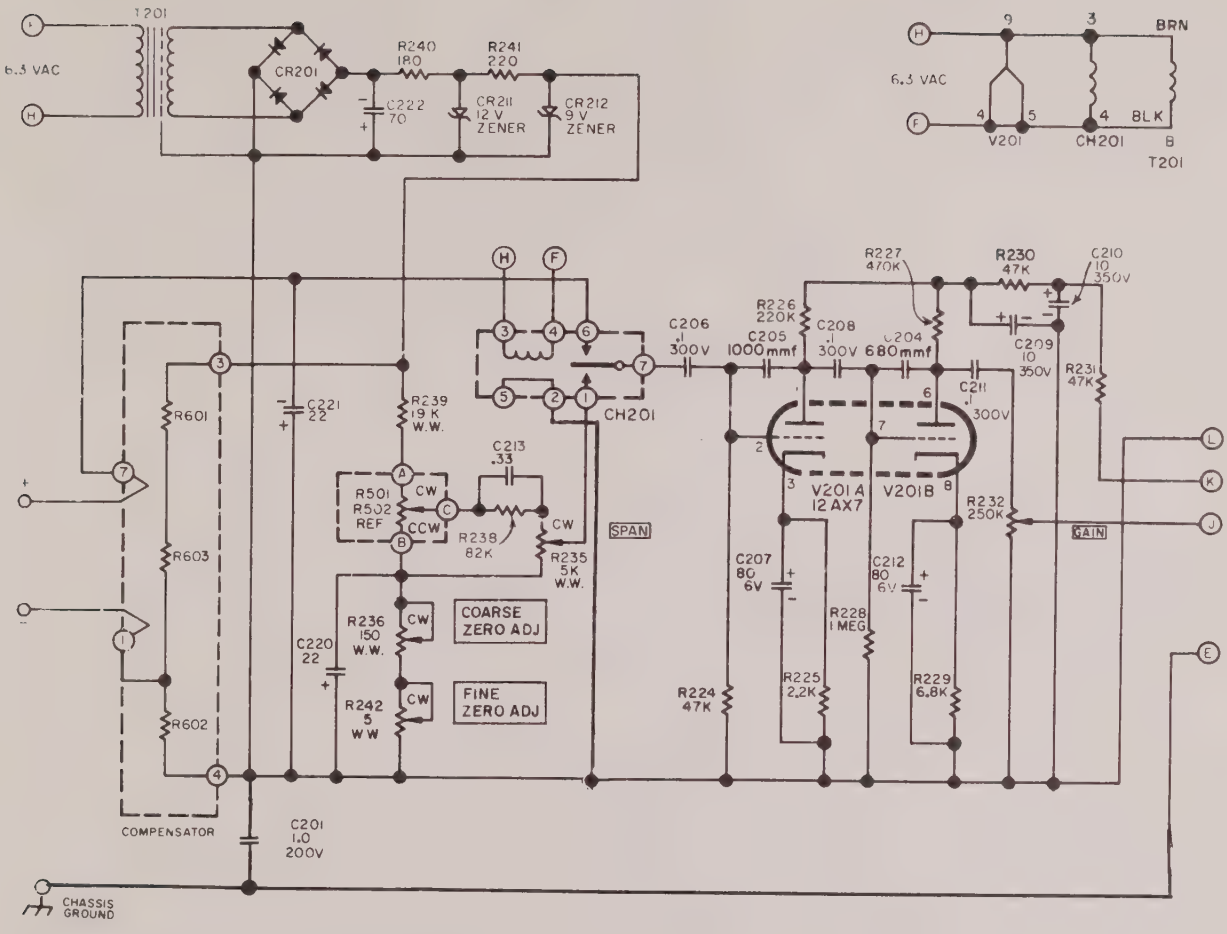


Figure 2-21: T-22A Thermocouple Input Chassis



NOTES:

1. ALL RESISTORS 10%, 1/2W UNLESS OTHERWISE NOTED
2. THIS DRAWING IS SCHEMATICALLY EQUIVALENT TO VARIAN DRAWING 962663 F

Figure 2-22: T-22A Thermocouple Input Chassis Schematic

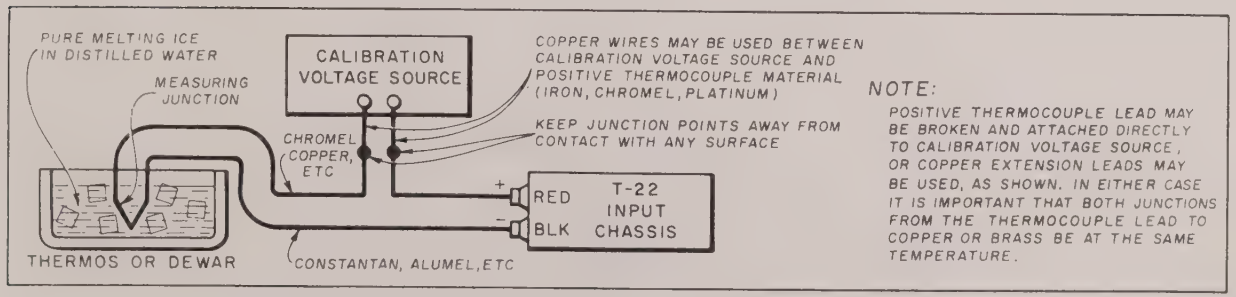

PURE MELTING ICE IN DISTILLED WATER
MEASURING JUNCTION
CALIBRATION VOLTAGE SOURCE
COPPER WIRES MAY BE USED BETWEEN CALIBRATION VOLTAGE SOURCE AND POSITIVE THERMOCOUPLE MATERIAL (IRON, CHROMEL, PLATINUM)
KEEP JUNCTION POINTS AWAY FROM CONTACT WITH ANY SURFACE
CHROMEL COPPER, ETC
RED
BLK
T-22 INPUT CHASSIS
THERMOS OR DEWAR
CONSTANTAN, ALUMEL, ETC
NOTE:
POSITIVE THERMOCOUPLE LEAD MAY BE BROKEN AND ATTACHED DIRECTLY TO CALIBRATION VOLTAGE SOURCE, OR COPPER EXTENSION LEADS MAY BE USED, AS SHOWN. IN EITHER CASE IT IS IMPORTANT THAT BOTH JUNCTIONS FROM THE THERMOCOUPLE LEAD TO COPPER OR BRASS BE AT THE SAME TEMPERATURE.

Figure 2-23: T-22A Calibration Source

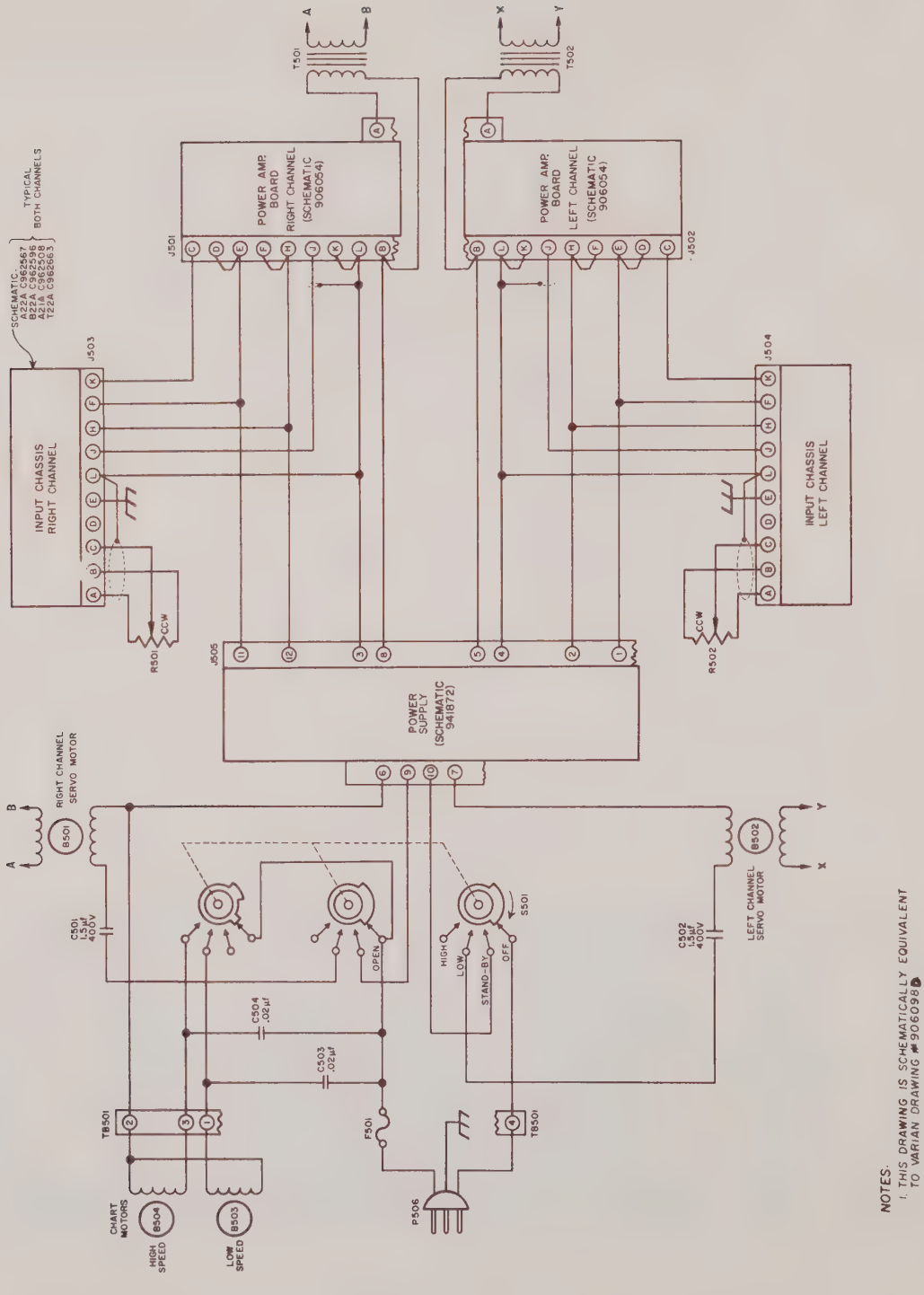


Figure 2-24: G-22A Recorder Interconnect Diagram

operation

3.0 G-22A OPERATING INSTRUCTIONS

3.1 GENERAL

Before attempting to install or operate the Model G-22A Recorder, please read the warranty information at the rear of this manual, and inspect the instrument carefully. It has been adjusted, calibrated, and thoroughly tested prior to shipment. Except for ink and chart paper, it is ready to operate.

3.2 POWER REQUIREMENTS

The Model G-22A Recorder operates from 115 or 230 volt, 50 or 60 Hz single-phase line. A ground conductor is contained in the power cord, which terminates in a three-prong plug, the tubular pin being the ground connection. If the wall receptacle does not have a ground connection, a three-to-two terminal adapter must be used. For safety and for reduction of hum pickup the adapter ground lead should be well grounded.

3.3 SIGNAL, AND SIGNAL SOURCE REQUIREMENTS

Changes in the measured signal should not exceed the Model G-22A Recorder's one-second full-span balancing time. No damage to the recorder will result from fast-changing signals, but the recording will not be an accurate representation. Source resistance can range from a fraction of an ohm to the maximum resistances stated in the specifications. Source resistances which exceed maximum limits will result in greater dead band, particularly in the range of minimum span. Except when in the 10-mv span range, the Type B-22A Input Chassis will load the signal source with the resistance of its input voltage dividers.

3.3.1 Signal Connections

Because the Model G-22A Recorder converts the d c input signal to an a c signal of line frequency, any noise frequency results from coupling to the power line. Two types of coupling can occur. With high source resistance, coupling may be electrostatic. Shielded cable should be used between the recorder and the signal source to eliminate this type of coupling. The shield should be attached to the recorder chassis ground only, and the two internal leads connected to J201 and J202. Attaching the shield to both the recorder and measured-source chassis grounds may cause ground loops.

With low source resistances coupling is mainly inductive. Shielding is not required, but the two leads from the measured source to the recorder should be twisted together and kept as short as possible.

When operating the recorder with input signals biased above ground potential, a d c offset may occur in very humid conditions. This is caused by insulation leakage combined with the high gain of the servo amplifier. These effects may be offset by the ZERO control.

Signal voltages greater than those specified can be applied through suitable voltage dividers. Care should be observed in calculating scale factors.

3.4 INSTALLING THE CHART

To install the chart, proceed as follows:

(1) Note the callout nomenclature of Figure 3-1.

(2) Lift scale and unsnap platen from spacer rods.

(3) Unwrap one end of the chart roll. Fold or cut chart corners as shown. With chart recording surface toward rear of recorder, thread chart through guide slot until it engages the drive sprockets on both sides.

(4) Place HIGH-N- LOW gear shifter in "N" position.

(5) Advance chart by hand, and replace platen.

(6) Check that the chart re-roll tube is in place and that slots engage with teeth of the take-up pulley on the left.

(7) Unroll a length of chart paper sufficient to reach the re-roll tube. Tape the chart paper to the re-roll tube as shown in Figure 3-1.

(8) Wind several turns of chart paper on the re-roll tube by rotating the chart take-up drive pulley. Take up any remaining slack in the chart paper so that it is flat against the platen.

3.4.1 Chart Paper Replacement

Varian chart paper is marked in the margin with the number of feet remaining on the supply roll. At any point the supply roll can be replaced with a full roll by using the procedure given in paragraph 3.4. However, the cardboard tube from the old supply roll must be used as the re-roll tube. Always turn the recorder OFF when replenishing chart paper.

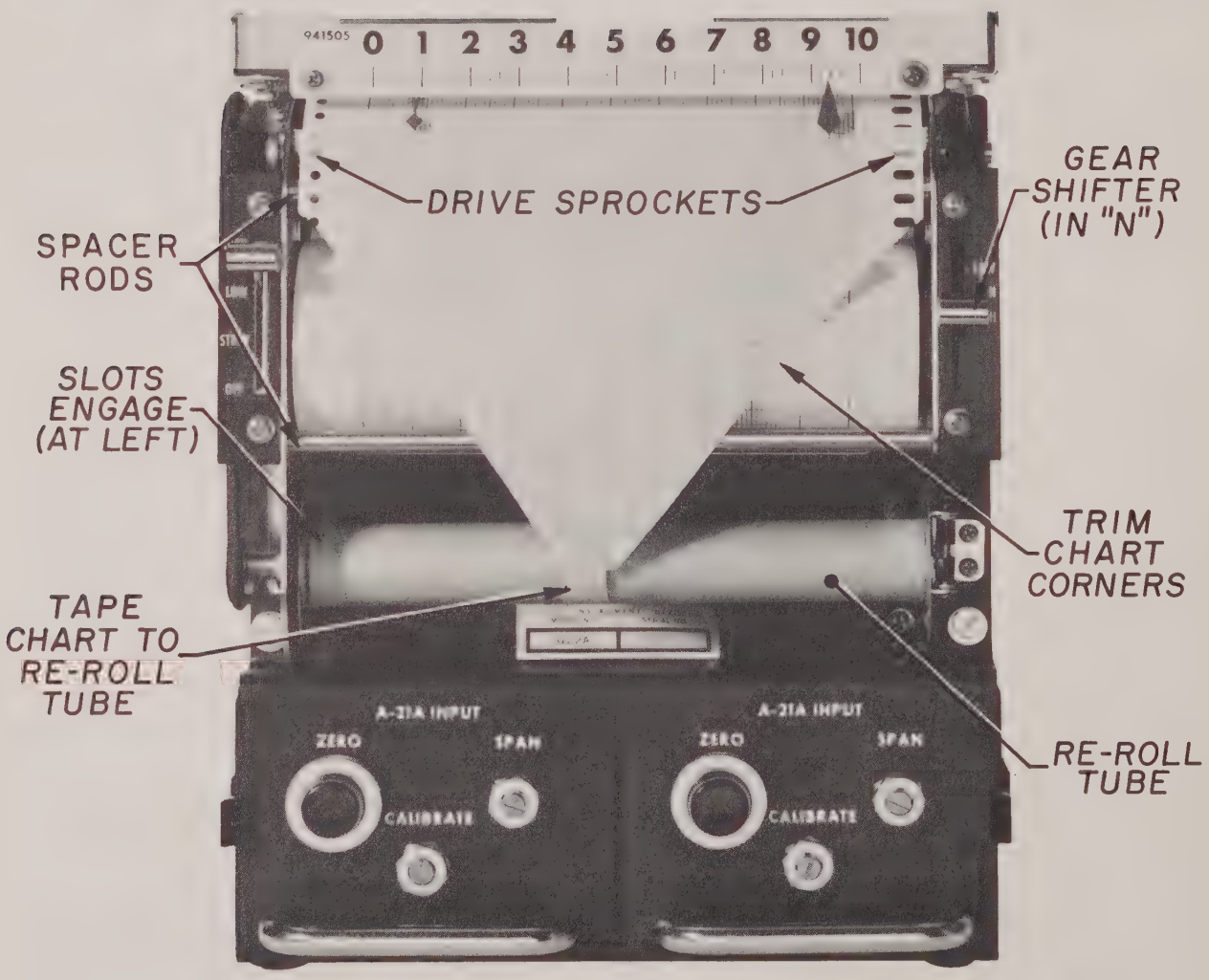


Figure 3-1: Chart Installation Procedure

3.5 INSTALLING PENS AND INK SYSTEM

(1) Remove the main recorder assembly from its case by loosening the two captive screws, one on each side of the assembly, and grasping the handle on either input chassis.

(2) The recorder is shipped with pens in place. When replacing pens, install the red pen on the rear pen bearing, and the blue pen on the front. Pens snap onto the pen bearing using clips. See that the lower holes in the grip rings through which the pen drive cords are fastened line up with the drive cord pulleys at the edges. If pens are installed so the grip rings are rotated too high or too low, improper pen contact with the chart will occur. See Figure 3-2.

(3) Mount the ink cartridges supplied in the kit in the mounting bracket on top of the main recorder assembly. The cartridge(s) containing red ink should be mounted in the right end of the bracket.

(4) Connect capillary tubing between pens and piercing & priming units supplied in the kit. Note that the tubing to the red ink cartridge(s) passes between the guide rods. See Figure 2-4.

(5) Insert the piercing & priming units into ink cartridges, selecting the color of ink on the basis of the color of the pen to which the capillary tube is connected. See Figure 2-4.

(6) Prime each pen by slowly squeezing the bulb on top of the primer unit, holding momentarily, and releasing. Repeat until ink is forced through the tubing to the pen. An alternate means of filling pen is to attach the syringe (with capillary tubing), furnished in the ink kit, to the pen tip. Draw on the syringe plunger until ink reaches the pen. Ink drawn into the syringe can be replaced in the ink cartridge.

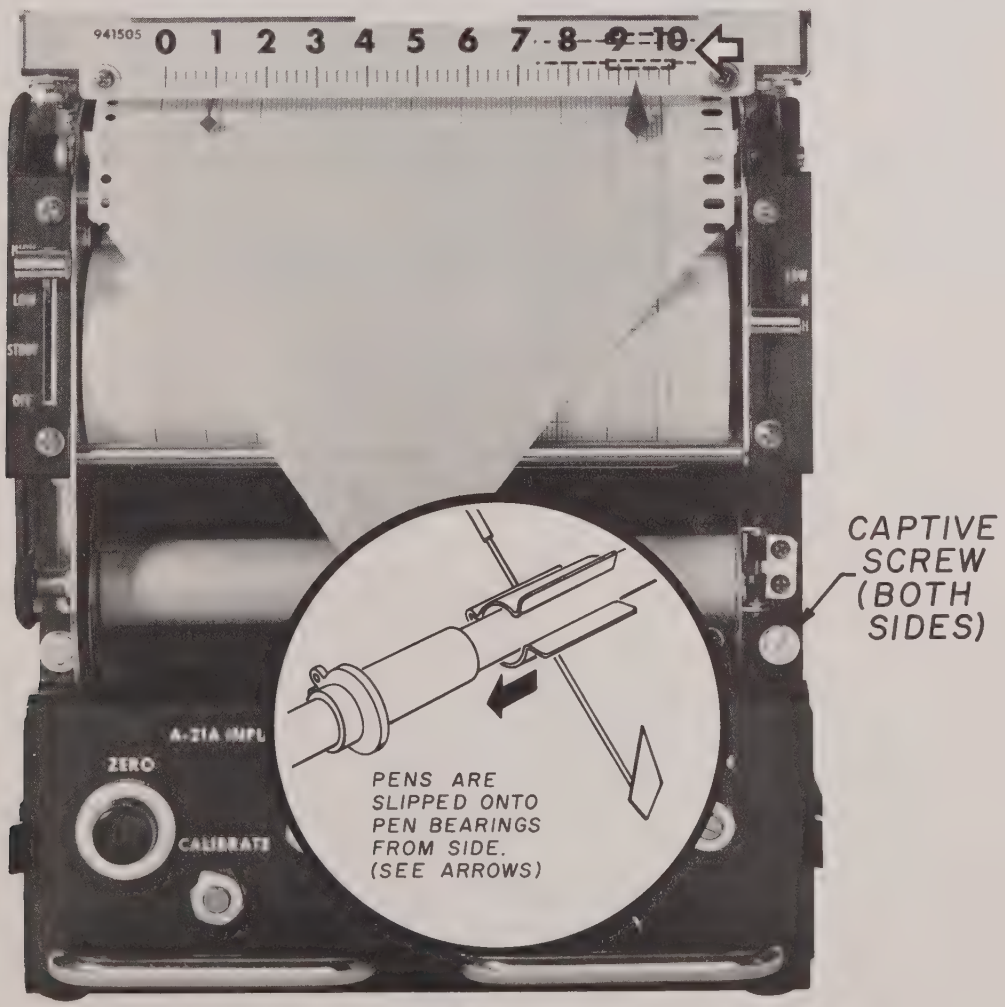


Figure 3-2: Details of Pen Installation Procedure

3.6 REVIEW OF CONTROL LOCATION AND FUNCTIONS

The following controls are located on the main recorder assembly:

LOW-N-HIGH gear shifter—this control provides a four-to one chart speed reduction between HIGH and LOW. N is a neutral position.

HIGH-LOW-STDBY-OFF switch—this switch controls recorder power, and when the recorder is supplied with two chart drive motors, selects the low- or high-speed motor. In STDBY amplifiers are on and only the control winding of the servo motor is energized. In LOW and HIGH the low- and high-speed chart drive motors are operative, and the line winding of the servo motor is energized. If only one chart drive motor is supplied, it operates in HIGH only.

The following controls are located on the input chassis, the right-hand chassis controlling the red pen. Refer to the sections describing the input chassis for adjustment.

ZERO–adjusts the zero-signal pen position to any desired point on chart.

CALIBRATE—a fine span adjustment.

GAIN—servo amplifier gain adjustment.

SPAN adjustment

3.7 DETAILED OPERATING INSTRUCTIONS

(1) After installing chart paper and the ink systems, connect the recorder to an ac power line, observing considerations of Section 3.2.

(2) Place the HIGH-LOW-STDBY-OFF switch in STDBY, and the LOW-N-HIGH gear shifter in N. Allow recorder amplifiers to warm up for one minute.

(3) Short the signal input terminals together.

(4) Place the HIGH-LOW-STDBY-OFF switch in either HIGH or LOW.

(5) Adjust the ZERO control for the desired zero-signal pen position on the chart.

(6) Remove shorting connection across signal inputs and connect an appropriate signal source, observing considerations of Sections 3.3 and 3.3.1.

(7) Place the HIGH-LOW-STDBY-OFF switch and LOW-N-HIGH gear shifter in desired positions.

(8) The recorder is now ready to record.

service and maintenance

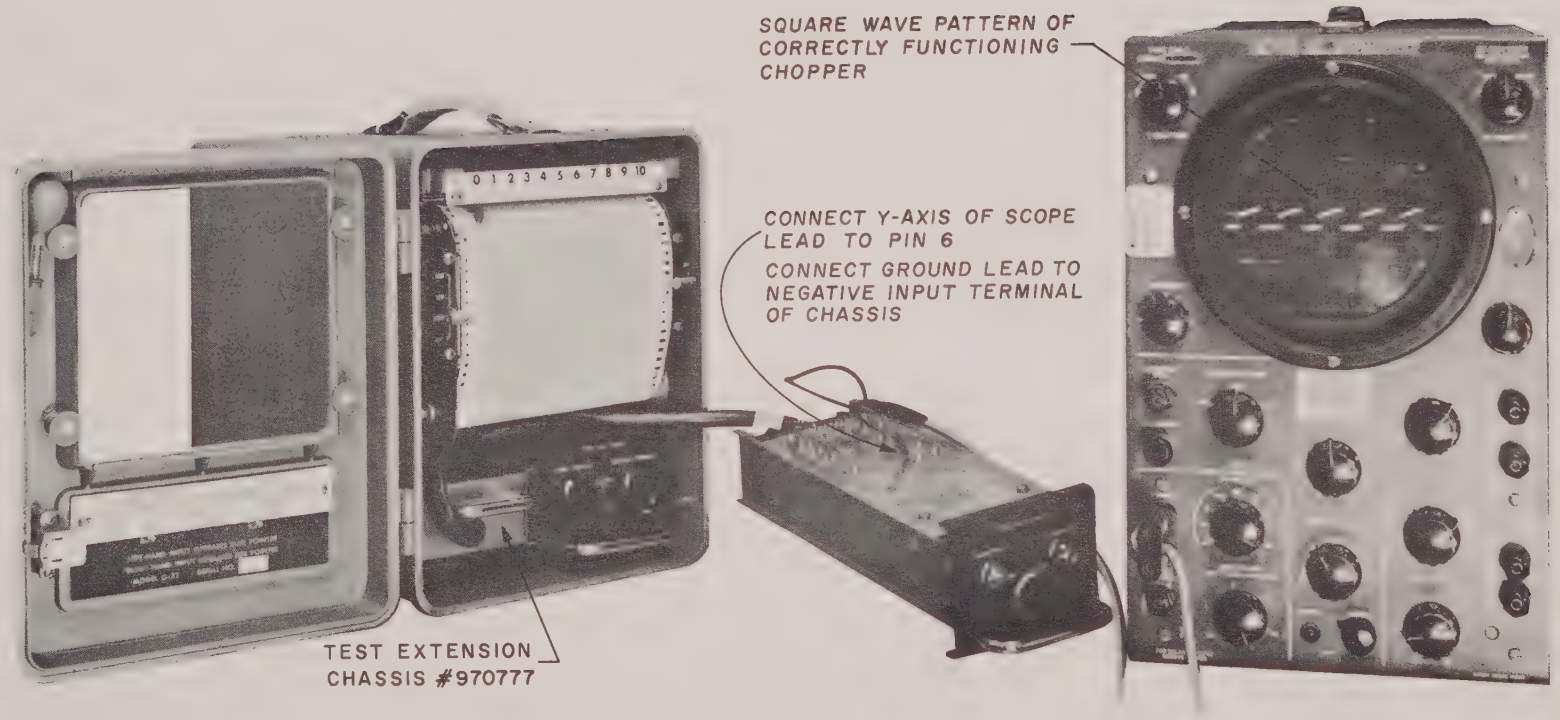


Figure 4-1: G-22A Chopper Test Procedure

4.0 SERVICE AND MAINTENANCE

4.1 GENERAL

Before attempting service, adjustments, and maintenance of new equipment, please read the warranty information at the rear of this manual.

The instructions which follow apply to Type A-21A, A-22A, and B-22A input chassis and main recorder assembly. Refer to Section 2.8 for detailed instructions on Type T-22A input chassis.

4.2 PERFORMANCE CHECKS AND ADJUSTMENT OF ELECTRONIC UNITS

The modular construction of the Model G-22A Recorder offers many service, maintenance, and troubleshooting shortcuts because major subassemblies may be checked by substitution. When one channel becomes inoperative, the input chassis, servo amplifier printed circuit board, tubes, reference cell, chopper, and power supply of the operative channel may be exchanged with those of the inoperative channel until the faulty subassembly is located.

4.2.1 Mercury Reference Cell

A mercury cell is used in the Type A-21A Input Chassis as the reference voltage source. To eliminate surface-charge effects and thus allow the recorder to be used with full accuracy immediately upon warmup, the cell is allowed to discharge continuously whether the recorder is on or off. Once the cell is installed, its life is about four months, after which its voltage drops to an unusable value. Low reference cell voltage will cause a decrease in span.

To replace the cell, unsnap it from its holder in the input chassis. Replace with Varian part number 74-101-550, making sure that the positive terminal (marked on cell) faces the rear of the chassis, or the red lead on the cell holder.

NOTE

Remove protective paper cover before installing mercury cell.

4.2.2 Electronic Reference Voltage Supply

The electronic reference voltage supply schematic is shown in Section 2. The operation of this unit may be checked as follows:

(1) Remove the two fastening screws which secure the unit to the input chassis, unplug the connector, and remove the unit from the input chassis.

(2) Place a 2.5k-ohm resistor across terminals 1 and 7 of the connector plug.

(3) Supply 6.3 vac to terminals 3 and 4 of the connector plug.

(4) Measure the voltage across terminals 1 and 7. This should be within ± 10% of 8 vdc. Incorrect operation will result in wide deviation from this value.

If the electronic reference voltage supply is faulty, do not attempt to adjust R404, or to replace components, other than the mercury cell, in the A-21A input chassis.

4.2.3 Chopper

If the chopper is suspected of malfunctioning, it can be checked as follows:

(1) First remove both input chassis from recorder and reverse chassis position. If malfunction switches to other channel, refer to Figure 4-1, remove input chassis containing suspected chopper, and connect it to recorder using test extension chassis 970777.

(2) With input chassis thus exposed, locate terminal 6 on the chopper socket. Connect the positive terminal of an oscilloscope Y-axis input to terminal 6 of the chopper socket. Connect the negative terminal to the negative recorder input terminal.

(3) With the recorder plugged into the a c line, and with the HIGH-LOW-STDBY-OFF switch in STDBY, apply a full-span input voltage to the recorder, and set the scope Y-axis gain to the correct range for this signal.

(4) If ringing or an incorrect duty cycle is shown, discard the chopper, and replace with Varian part number 901-335. While the test arrangement is set up, test the new chopper. A clean square wave should be produced, and a 50% duty cycle indicated (equal on and off times).

(5) If a test extension chassis is not available, the alternative chopper test method detailed in Figure 4-2 may be used, or the bottom of the recorder can be removed for access to the input chassis.

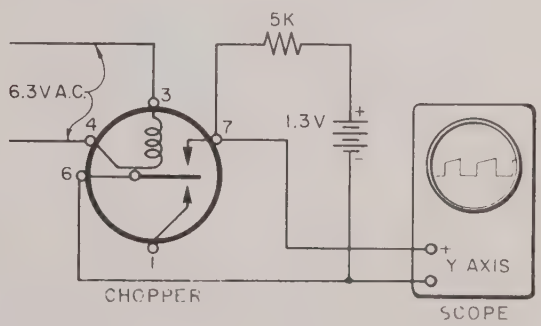


Figure 4-2: Alternative Chopper Test Circuit

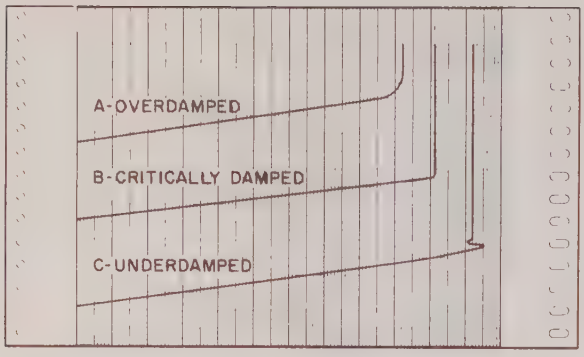


Figure 4-3
Representative Traces of Three Damping Conditions

4.2.4 Servo Amplifier Gain

The location of the servo amplifier gain control, R-232 in the Type A-21A Input Chassis, is shown in the schematic, in Section 2. When tubes age, or when span is readjusted, gain adjustment is usually necessary. Rotate the gain control clockwise until oscillation or "jitter" occurs in the servo motor (visible at the pens), and then back off until oscillation just stops.

4.2.5 Balancing Time

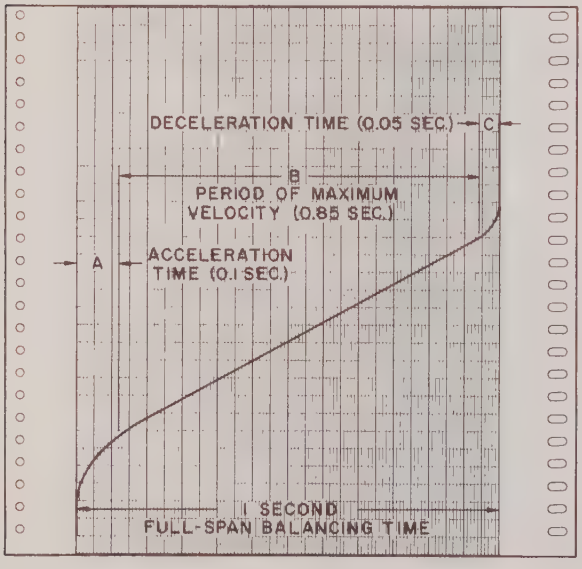


Figure 4-4
Representative Trace of Correct Balancing Time

Figure 4-4 is a test trace produced by a full-scale step input to the recorder. The trace consists of three segments. A, acceleration time, B, period of maximum velocity, and C, deceleration time. As indicated in Figure 4-4, acceleration time is less than 0.1 second, maximum velocity time approximately 0.8 second, and deceleration time 0.05 second. The recorder was adjusted for critical damping, i.e., fastest response with zero overshoot.

Check balancing time as follows:

(1) Short the signal input terminals together.

(2) Adjust both the HIGH-LOW-STDBY-OFF and the HIGH-N-LOW gear shifter to HIGH. The usefulness of this step depends on the chart speeds supplied. If they are sufficiently high to provide a trace similar to that of Figure 4-4, then comparison of the trace obtained and the Figure may be helpful.

(3) Rotate the ZERO control suddenly to the extreme counterclockwise position, then fully clockwise. Roughly note balancing time by checking against wrist watch, or inspect the recorded trace. If balancing time is excessive, or if chart speeds are sufficient to indicate a nonlinear trace, binding in the mechanical section is indicated.

4.2.6 Calibration

Calibration of mercury-cell equipped recorders should be performed whenever precise recording is required because of the slight mercury-cell voltage decay with time. The following steps also apply to input chassis equipped with electronic reference voltage supplies. To calibrate either type of input chassis, proceed as follows:

(1) Short the signal input terminals together.

(2) Turn HIGH-LOW-STDBY-OFF switch to HIGH or LOW.

(3) Adjust ZERO control until pen rests at left-hand chart margin.

(4) Remove shorting connection between input terminals.

(5) Apply an accurate full-scale input signal to input terminals.

(6) Rotate CALIBRATE control until the pen balances at right-hand chart margin.

4.2.6.1 Calibration Voltage Source

Figure 4-5 is a schematic of a simple, accurate calibration voltage source. Resistance values should be within $\pm 1\%$, and a new mercury cell, aged for approximately four hours in the circuit, should be used. Component values for various full scale voltages are contained in the chart.

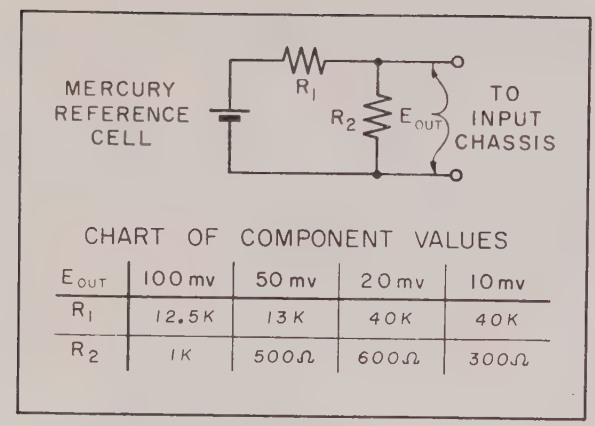


CHART OF COMPONENT VALUES

E_{OUT}	100 mv	50 mv	20 mv	10 mv
R_1	12.5K	13K	40K	40K
R_2	1K	500Ω	600Ω	300Ω

Figure 4-5: Simple Calibration Voltage Source

4.2.7 Zero Adjustment

The ZERO control adjusts the zero-signal pen position to any desired point on chart.

4.2.8 Span Adjustment

Span of Types A-21A and A-22A Input Chassis is adjusted at the factory according to the purchaser's order specifications, for spans of 5 mv through 100 mv. The most important requirement in making an accurate span adjustment is an accurate input signal.

To adjust span, proceed as follows:

(1) Remove input chassis from recorder. For all span ranges V 201 = 12AX7. Install tube and replace input chassis.

(2) Turn HIGH-LOW-STDBY-OFF switch to HIGH or LOW.

(3) Short the signal input terminals together.

(4) Turn span control approximately ¾ turn counterclockwise.

(5) Adjust ZERO control until pen rests at left-hand chart margin (viewed from front of recorder).

(6) Remove connection from input terminals.

(7) Apply an accurate full scale voltage.

(8) Adjust span control until pen rests at right-hand chart margin (viewed from front of recorder).

(9) Adjust the servo amplifier gain as outlined in Section 2.5.3, Gain Control.

(10) Repeat steps (5) through (8) above.

(11) Adjust servo amplifier gain, and lock span adjustment.

4.2.9 Deadband

Check deadband as follows:

(1) Remove the recorder from its case by loosening the two captive screws, one on each side of the assembly.

(2) Short the signal input terminals together.

(3) Turn HIGH-LOW-STDBY-OFF switch to HIGH, and LOW-N-HIGH gear shifter to HIGH.

(4) Adjust ZERO control until pen balances in chart center.

(5) Twist servo motor shaft by hand until the pen moves ¼ inch to one side or the other of the balance position slowly, braking the return by holding the servo motor shaft.

(6) Allow an inch of chart paper to unroll, then turn servo motor shaft in opposite direction, repeating (5) above.

(7) Note the final position difference between the first trace and the second. This is the dead zone.

4.2.10 Voltage Test Points

Figure 4-6 shows voltages at tube socket pins. The voltage at V201 pins were taken from a Type A-21A Input Chassis and are typical of all chassis.

The servo amplifier gain control was fully counterclockwise, and the signal inputs were strapped to-

TUBE	PIN ①	②	③	④	⑤	⑥	⑦	⑧	⑨
V201	120v	0.0v	1v	3.2vAC	3.2vAC	130v	0.0v	1.2v	3.2vAC
V302	135v	0.0v	1.4v	3.2vAC	3.2vAC	142v	0.0v	1.4v	3.2vAC
V303	0.0v	15v	3.2vAC	3.2vAC	260v	267v	0.0v		

Figure 4-6: Voltage at Tube Socket Pins

gether. A vacuum tube voltmeter was used, and all voltages were measured with respect to amplifier floating ground, that is, the input ground terminal was not strapped to chassis ground.

Access to V201 in the input chassis may be gained by using the test connector 970777, or by removing the bottom of the recorder. Other tube pins are accessible from the top of the servo amplifier printed circuit board. Voltages shown are ±10%. Pins 3 and 8 of V201 and V-302 are always approximately one volt positive with respect to pins 2 and 7 for proper grid bias. If a positive voltage appears at pins 2 and/or 7, the tube may be gassy, or capacitors C206 or C302 may be leaky. If the voltages at pins 3 and 8 of V201 and V302 are significantly lower, tubes may be weak. In this case voltages at pins 1 and 6 will probably be higher. V302 may show a small a c voltage at pin 2, the grid. This is normal.

4.2.11 Power Supplies

Low B+ voltage and excessive ripple can usually be traced to faulty diodes. Complete power supply failure indicates shorted diodes and filter capacitors. If a power supply channel fails, all diodes and the filter capacitor should be replaced.

4.3 PERFORMANCE CHECKS AND ADJUSTMENT OF MECHANICAL UNITS

4.3.1 Drive Cord Adjustment

To adjust the drive cord, proceed as follows:

(1) Remove the recorder from its case by loosening the two captive screws, one on each side of the assembly.

(2) See Figure 4-7, item #5, the drive cord adjusting screw. Rotate the servo motor shaft fully counterclockwise until the screw is at its uppermost position.

(3) Raise chart scale. Loosen drive cord adjusting screw. (Drive cord tension is maintained by a spring inside the drum which is fastened to one end of the drive cord and secured to the drum by a cotter pin.)

(4) Adjust drive cord tension by rotating the drive cord adjustment arm, item #6, until the coils of the tension springs are approximatly ¾ inch from the hole opening in the sheave. Secure the adjusting screw. To loosen, allow spring tension to pull drive cord in opposite direction.

4.3.2 Drive Cord Stringing

The following steps cover drive cord stringing and apply to both channels.

(1) Refer to Figure 4-7. Tie one end of drive cord (#1) to (#2). Use square knot. Slide spring into hole (#3). Insert cotter pin (#4) through intersecting hole in sheave and spring eye. Flatten cotter pin against back of sheave.

(2) Wind a full turn of cord on the sheave in a clockwise direction, as in Figure 4-7.

(3) Rotate servo motor shaft fully counterclockwise until motor stop strikes bumper.

(4) Tie drive cord to lower hole in pen bearing grip ring using a single overhand knot. For the front pen bearing, the grip ring should be approximately ¼ inch in from the highest scale mark after tying. For the rear bearing, the grip ring should be as close as possible to the right hand pulley without touching it.

(5) For returning drive cord to sheave, follow Figure 4-7. Feed drive cord through remaining hole on top of the sheave. Bring the drive cord out through hole on front of sheave, and attach drive cord hook to adjusting arm. Adjust drive cord tension as described in Section 4.3.1.

4.3.3 Balancing Potentiometer

If the balancing potentiometer becomes "noisy", excessive deadband, "chattering" or a recurring transient at one particular point on the chart will occur. "Noise" is due to intermittent wiper contact resulting from dirt and wear. For best system performance the potentiometer should be replaced. Due to the precision of balancing potentiometers used in the Model G-22A Recorder, disassembly for maintenance and cleaning should be undertaken only by experienced persons, The following instructions cover potentiometer removal and replacement:

(1) Refer to Figure 4-8. Loosen the drive cord sheave from the balancing potentiometer shaft by loosening the two Allen-head set screws.

(2) Loosen the flexible shaft coupler between servo motor and potentiometer shaft by loosening the two Allen-head set screws in each half. Slide the flexible shaft coupler onto the servo motor shaft.

(3) Unfasten the leads to the potentiometer, noting the lead location.

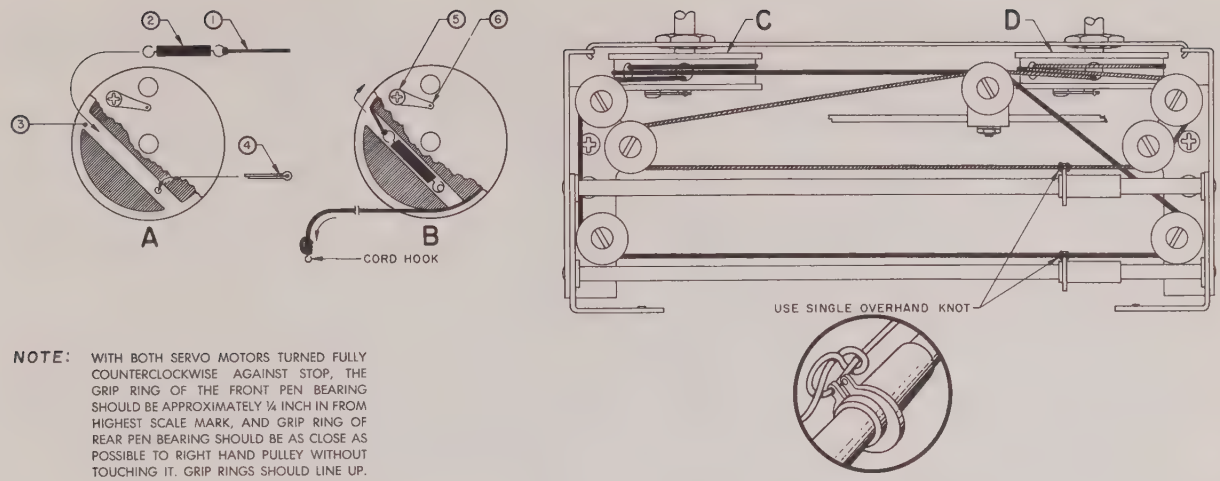

A
B
CORD HOOK
C
D
USE SINGLE OVERHAND KNOT
NOTE: WITH BOTH SERVO MOTORS TURNED FULLY COUNTERCLOCKWISE AGAINST STOP, THE GRIP RING OF THE FRONT PEN BEARING SHOULD BE APPROXIMATELY ¼ INCH IN FROM HIGHEST SCALE MARK, AND GRIP RING OF REAR PEN BEARING SHOULD BE AS CLOSE AS POSSIBLE TO RIGHT HAND PULLEY WITHOUT TOUCHING IT. GRIP RINGS SHOULD LINE UP.

Figure 4-7: Drive Cord Stringing Procedure

(4) Remove the potentiometer mounting nut and lockwasher, and remove potentiometer and shaft from recorder. Tape the sheave in place to keep the drive cord properly strung.

(5) To replace the potentiometer, first assemble the potentiometer, its lockwasher, and mounting nut on the potentiometer mounting bracket, and position potentiometer so that its terminals are in their uppermost position. Secure mounting nut. Slide sheave onto potentiometer shaft. Do not secure.

(6) Fasten leads to potentiometer in their original positions.

(7) Slide flexible shaft coupler onto potentiometer shaft, but do not secure. The potentiometer is now installed. It will be necessary to phase the potentiometer as covered in Section 4.3.4 below.

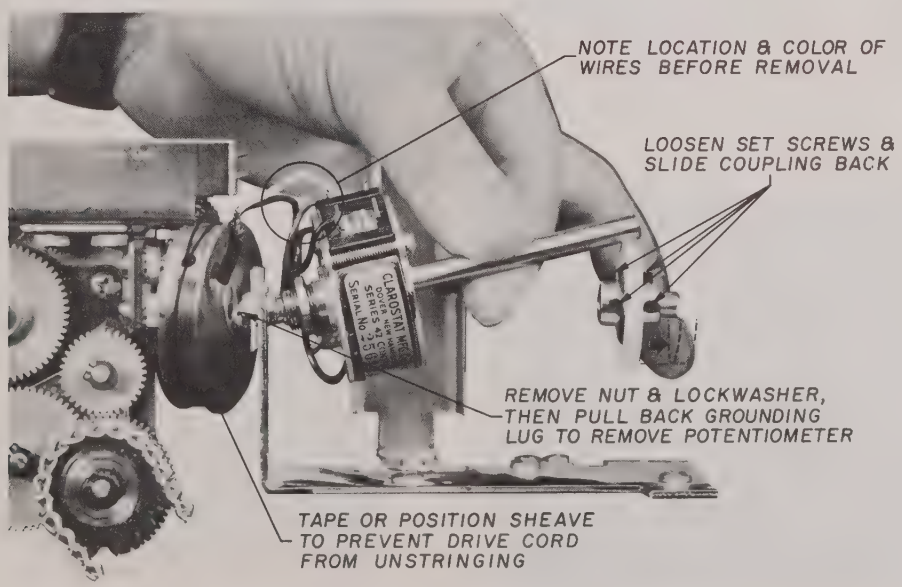

NOTE LOCATION & COLOR OF WIRES BEFORE REMOVAL
LOOSEN SET SCREWS & SLIDE COUPLING BACK
REMOVE NUT & LOCKWASHER, THEN PULL BACK GROUNDING LUG TO REMOVE POTENTIOMETER
TAPE OR POSITION SHEAVE TO PREVENT DRIVE CORD FROM UNSTRINGING

Figure 4-8: Balancing Potentiometer Removal

4.3.4 Potentiometer Phasing

To phase the potentiometer, proceed as follows:

(1) Rotate potentiometer to position all terminals in their uppermost position.

(2) Loosen the set screws in the flexible coupler and potentiometer sheave.

(3) Viewing recorder from front, rotate servo motor counterclockwise until the stop rests against the rubber bumper. Turn sheave so pen is positioned at zero.

(4) Rotate the potentiometer shaft counterclockwise. The resistance reading across the wiper and the ccw terminal should decrease with ccw rotation. (If the wrong terminal is chosen, the resistance will increase with ccw rotation.)

(5) When a resistance reading of 100 ohms ±10 ohms is reached, make sure that the servo motor and sheave are in the position of step (3) above, and tighten the set screws in the flexible shaft coupler and in the sheave.

4.3.5 Chart Drive Motors

Location of chart drive motors is shown in Figure 4-9. Normally a chart drive motor will not require replacement unless a change in motor speed is required. To remove and replace a chart motor, proceed as follows:

(1) Unplug recorder from a c line.

(2) Refer to Figure 2-3. Remove the drive chain by loosening the tension idler and slipping drive chain from sprockets.

(3) Remove power supply chassis retaining screw and remove power supply.

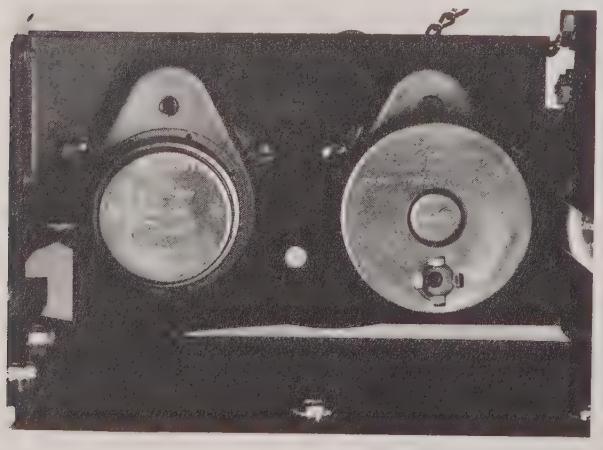


Figure 4-9: Location of Chart Drive Motors

(4) Carefully note location of motor power leads on terminal strip TB501 at rear of recorder frame, and disconnect leads.

(5) Remove motor mounting screws, and remove motor.

(6) To replace motor, assemble in reverse order, observing correct placement of motor leads on terminal strip TB501 and correct motor lead connections shown in Figure 4-12.

4.3.6 Drive Chain Adjustment

There is one adjustment of the drive chain. This is the tension adjustment made by loosening the tension idler, shown in Figure 2-3, and repositioning it to provide the desired tension. Excessive tension will overload the chart motor.

NOTE

Overloading the high-speed motors will cause a clattering noise, but no damage. Overloading the low-speed motors may cause severe damage, requiring complete motor replacement.

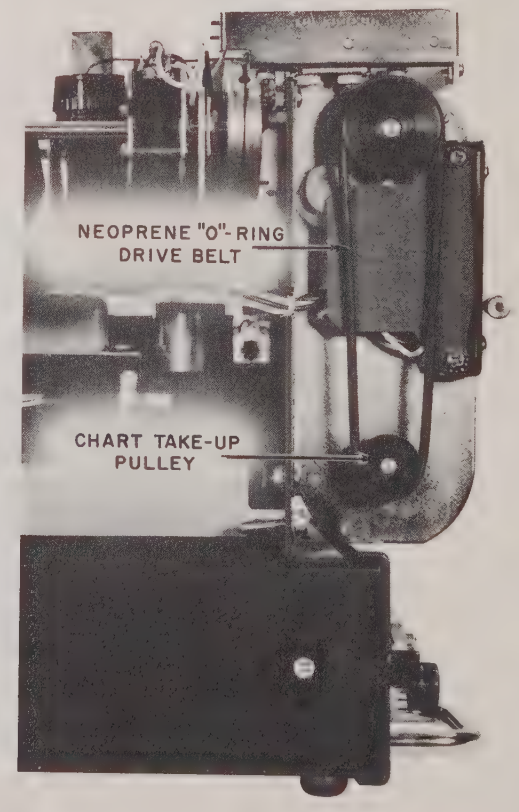


Figure 4-10: Chart Take-up Drive

4.3.7 Chart Paper Tension

The Model G-22A employs a slip-belt to maintain chart tension over the platen. Because chart tension depends upon belt tension, wear or stretching belt will reduce chart tension, and will require belt replacement.

4.3.8 Lubrication

The G-22A requires occasional cleaning and oiling. Figure 4-11 shows the lubrication points. Do not overlubricate. Excess oil merely holds dirt and dust and can be harmful. Light machine oil or S. A. E. 10W motor oil is recommended. DO NOT lubricate the pen bearings or the pen shafts. The pen bearing supplies its own lubrication. If binding of the pen bearings on the pen shaft occurs, clean the shafts thoroughly with an oil solvent.

4.3.9 Pen System

India or non-water soluble inks should not be used.

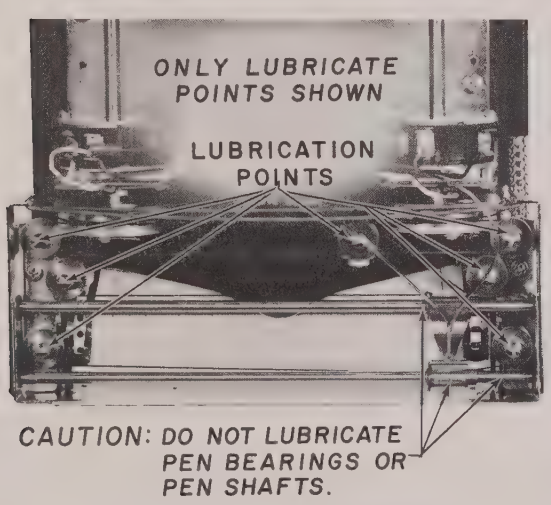


Figure 4-11: Lubrication Points

Recorder pens must be kept clean for proper functioning. For cleaning, water should be forced through the pen system. Cold water is normally satisfactory, but if the pen is obstructed, hot water may be used and a wire pen cleaner may be required to dislodge the obstruction. The syringe furnished with the recorder may be used as an aid in cleaning the pen. A small piece of plastic tubing installed between the syringe needle and the pen tip may be used as a connection when drawing water through the pen. To assure maximum performance, pens should be cleaned immediately after use. Pens and capillary feed tubes should be flushed with warm water.

Pens snap onto their bearings by clips, and may be removed by slipping capillary feed tubes from pen tubes, and sliding pens from pen bearings. When replacing pens, move the front pen to the left-hand chart margin, and the rear pen to the right-hand chart margin and see that the lower holes in the pen-bearing grip rings through which the drive cords are fastened line up with the drive cord pulleys. If pens are installed so that grip rings are too high or too low, improper pen contact with the chart will occur.

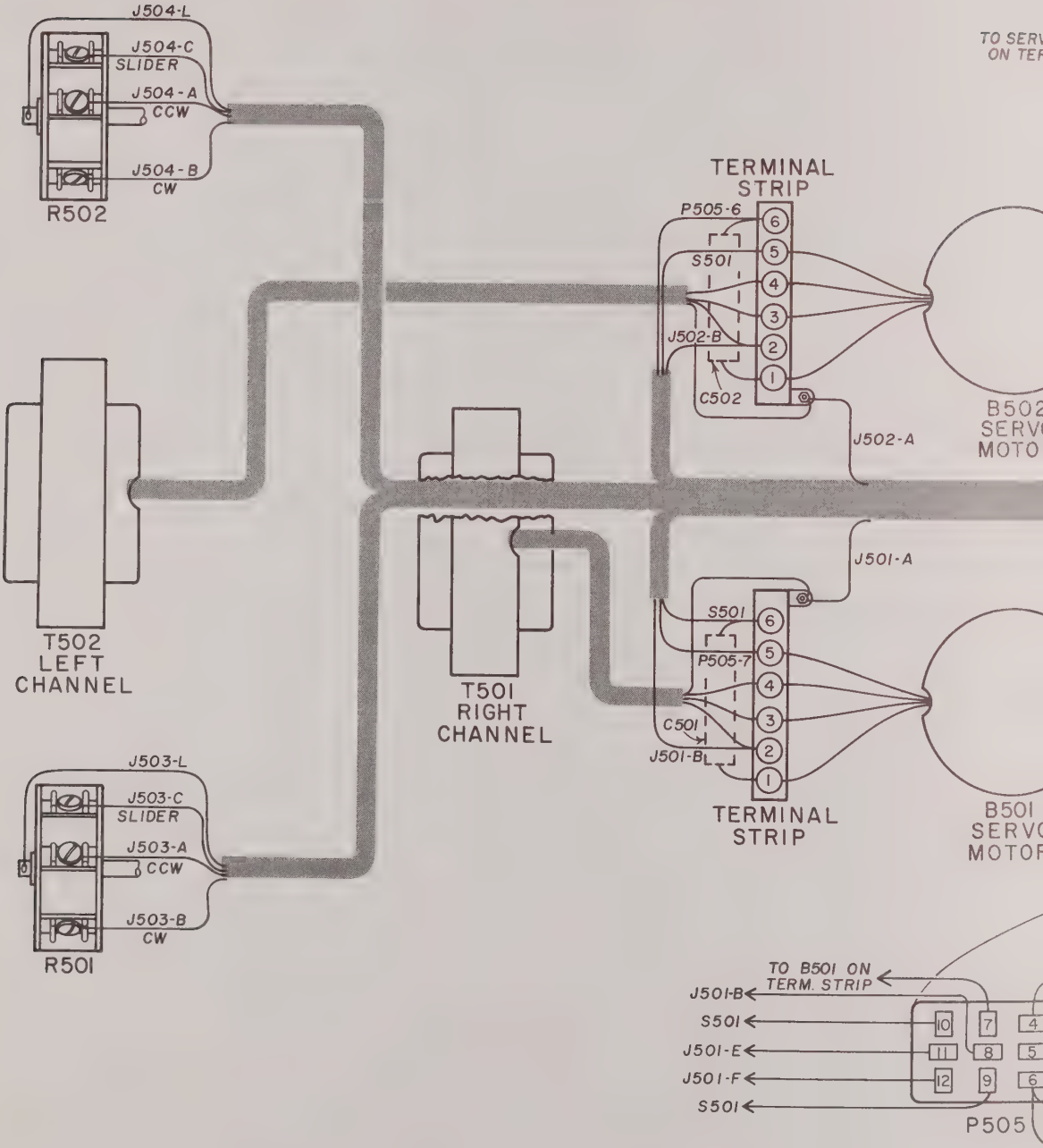
4.4 TROUBLESHOOTING CHART *(See following page)*

The Troubleshooting Chart lists possible troubles. Remember that G-22A modular construction provides troubleshooting shortcuts by allowing the components of an operative channel to be substituted for those of an inoperative channel until the general location of the difficulty is discovered. Full use should be made of this technique, as considerable time can be saved. The troubleshooting chart can then be used to determine the nature and cause of the difficulty.

TROUBLESHOOTING CHART

SYMPTOM	CAUSE	REMEDY
One or both recorder channels without power	Blown fuse	Replace fuse
Chart paper will not advance	Pen bearings rotated, pen holds chart	See Section 4.3.9
	Gear shifter in "N" position	Place gear shifter in HIGH or LOW
	Chart drive motor disconnected at terminal strip TB501	Make proper connection
	Drive gear loose on shaft	Tighten set screw
	Drive motor gear train inoperative	Replace drive motor
Chart paper loose over platen	Slots in left end of reroll tube disengaged	Engage
	Stretched take-up belt	Replace belt
Improper ink feed	Clogged pens	Clean with warm water
	Poor pen contact on chart	See Section 4.3.9
	Wrong type of ink	Empty system, rinse, and refill with recommended type
	Bubbles in capillary tubes	Draw ink through tubes with syringe.
Servo motor drives against mechanical stop and will not null	Servo, and potentiometer improperly phased	See Section 4.3.4
	Discharged reference cell	Replace reference cell
	Chopper inoperative	Replace chopper. See Section 4.2.3
	Input open	Check continuity
	Improper signal connections	See Sections 3.3 and 3.3.1
	V201 inoperative, or wrong tube	Switch input chassis. See Section 4.2.9
Cannot calibrate	Reference cell discharged	Replace reference cell
	Input signal exceeds full span range	See Section 4.2.8
Cannot adjust zero to chart edge	Instrument improperly calibrated	Calibrate. See Section 4.2.7
	Reference cell low	Replace reference cell
	Span improperly adjusted	See Section 4.2.8

SYMPTOM	CAUSE	REMEDY
ZERO control very one-sided for proper zero position of pen with signal input connected	Recorder not grounded or improper signal connections	See Sections 3.3 and 3.3.1
	Servo and potentiometer improperly phased	See Section 4.3.4
System insensitive, large dead band	Chopper operation poor	See Section 4.2.3
	Servo amplifier gain low	Adjust. See Section 4.2.4
	Source resistance too high	See Section 3.3
	Low line voltage	
Recorder cannot be properly damped	Excessive servo amplifier gain	Adjust. See Section 4.2.4
	Dirty potentiometer	Replace. See Section 4.3.3
	Incorrect span adjustment	See Section 4.2.8
Excessive balancing time	Low servo amplifier gain	Adjust. See Section 4.2.4
	Excessive dial-cord tension	See Section 4.3.1
	Source resistance too high	See Section 3.3
Pen oscillates	Excessive servo amplifier gain	Adjust. See Section 4.2.4
Pen "jitters" at a given point on chart	Dirty potentiometer	Replace. See Section 4.3.3
Full-span sweep across chart curved or irregular	Bind, or dirt in mechanical system	Check chart drive chain and clean pen rods
	Shorted potentiometer windings	Replace. See Section 4.3.3
Positive-going signals cause right-to-left pen travel	Reference cell installed backwards	Install correctly
Operator receives shock from recorder	Recorder not grounded	See Section 3.2
Intermittent, irregular transients	Severe line disturbances	Use line filter, isolation transformer
Line fuse blows, no B+	Shorted rectifier diodes or capacitors	See Section 4.2.11


J504-L
J504-C
SLIDER
J504-A
CCW
J504-B
CW
R502
TERMINAL
STRIP
P505-6
S501
J502-B
C502
J502-A
B502
SERVO
MOTO
T502
LEFT
CHANNEL
T501
RIGHT
CHANNEL
J501-A
S501
P505-7
C501
J501-B
TERMINAL
STRIP
B501
SERVO
MOTOR
J503-L
J503-C
SLIDER
J503-A
CCW
J503-B
CW
R501
TO B501 ON
TERM. STRIP
J501-B
S501
J501-E
J501-F
S501
P505

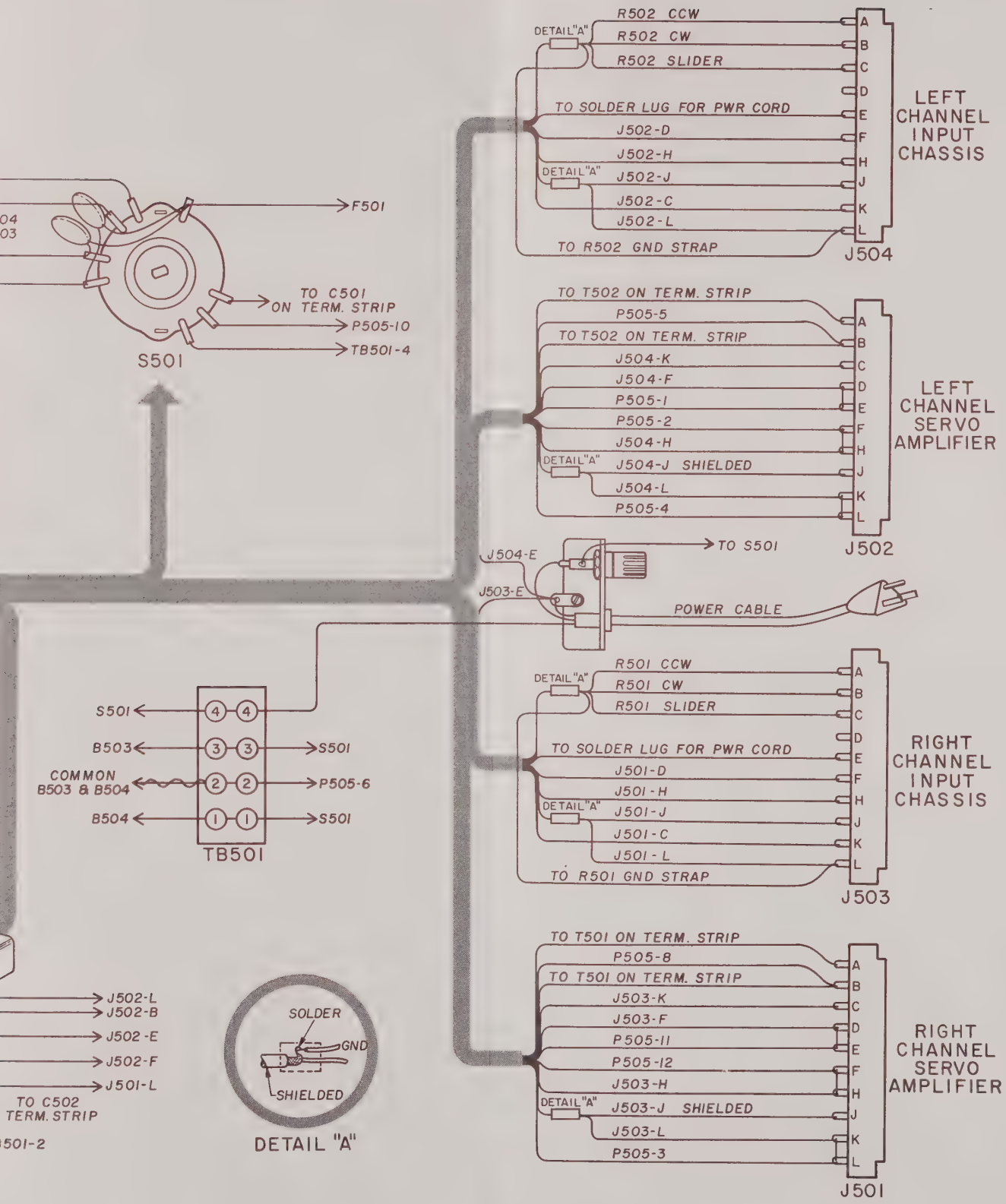


Figure 4-12: G-22A Pictorial Wiring Diagram

parts list

5.0 G-22A RECORDER PARTS LIST

5.1 POWER SUPPLY

Schematic Reference	Part Description	Varian Part Number
	Power Supply Assembly	906-080
C101	Capacitor, fixed, electrolytic, 20 μf, 450v	41-548-194
C104	Capacitor, fixed, electrolytic, 20 μf, 450v	41-548-194
CR101	Diode, rectifying	66-396-950
CR102	Diode, rectifying	66-396-950
CR103	Diode, rectifying	66-396-950
CR104	Diode, rectifying	66-396-950
CR105	Diode, rectifying	66-396-950
CR106	Diode, rectifying	66-396-950
CR107	Diode, rectifying	66-396-950
CR108	Diode, rectifying	66-396-950
F101	Fuse, 1/8 amp, 250v	67-121-312
F102	Fuse, 1/8 amp, 250v	67-121-312
P101	Connector, receptacle, 12 contacts	51-309-912
R101	Resistor, fixed, comp, 220K, 1/2w, 10%	32-202-622
R102	Resistor, fixed, comp, 220K, 1/2w, 10%	32-202-622
T101	Transformer, power, 115/230v, 50/60 Hz	961-458

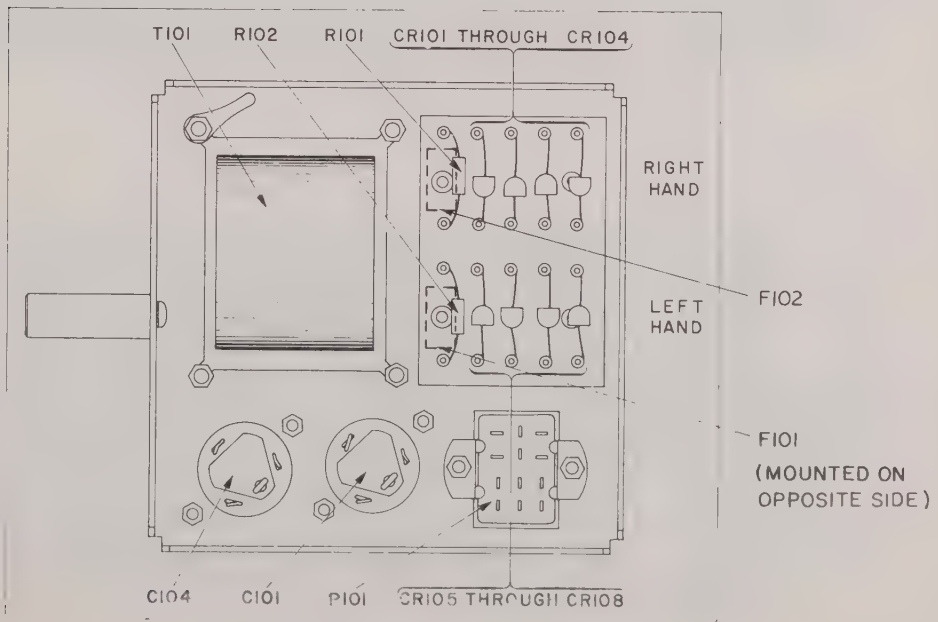


Figure 5-1: Power Supply

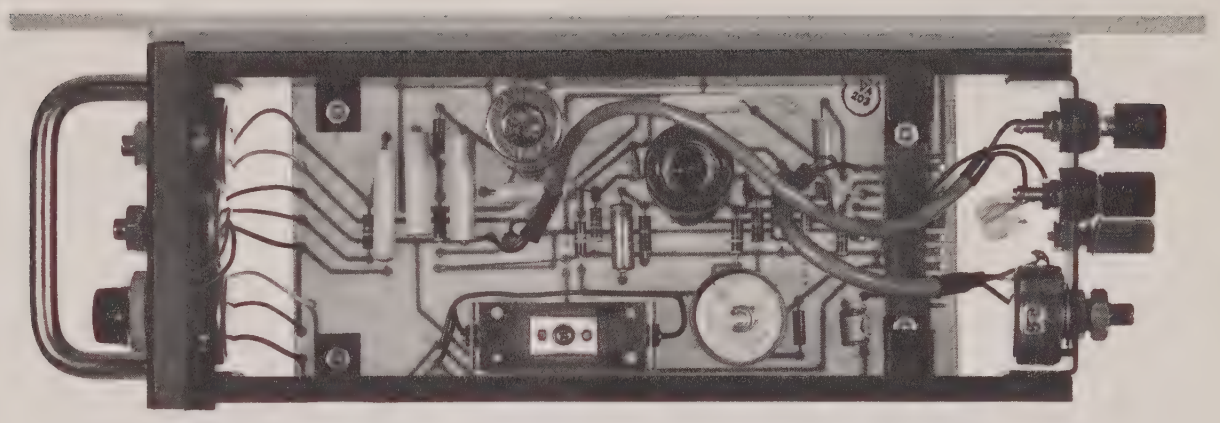


Figure 5-2: A-21A Input Chassis

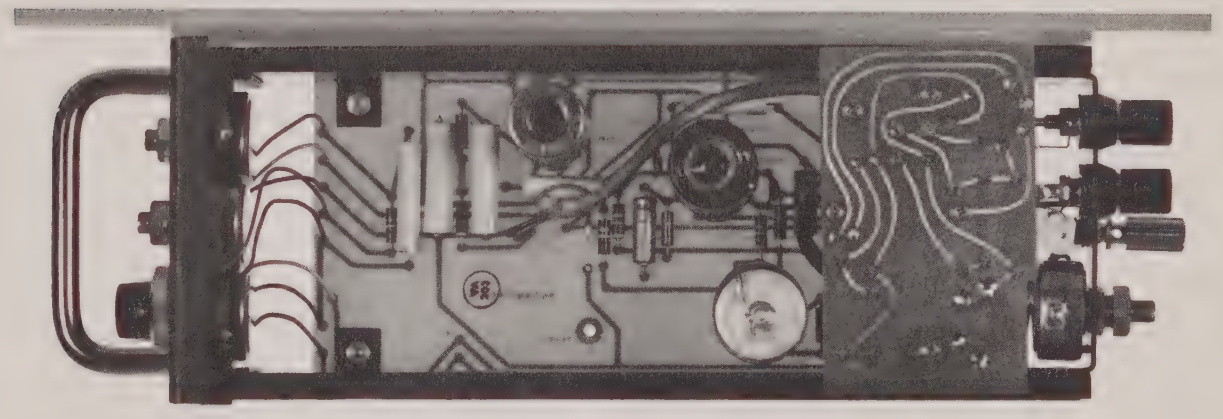


Figure 5-3: A-22A Input Chassis

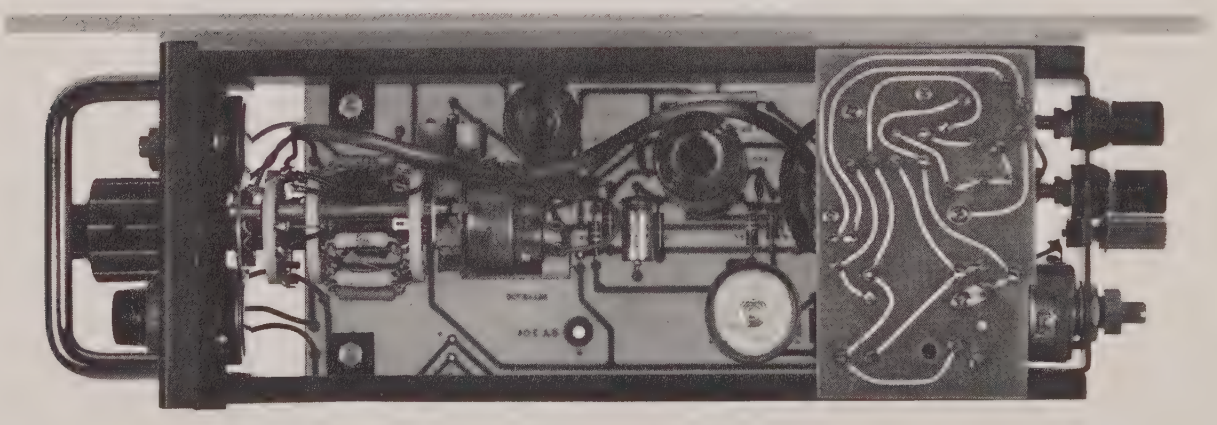


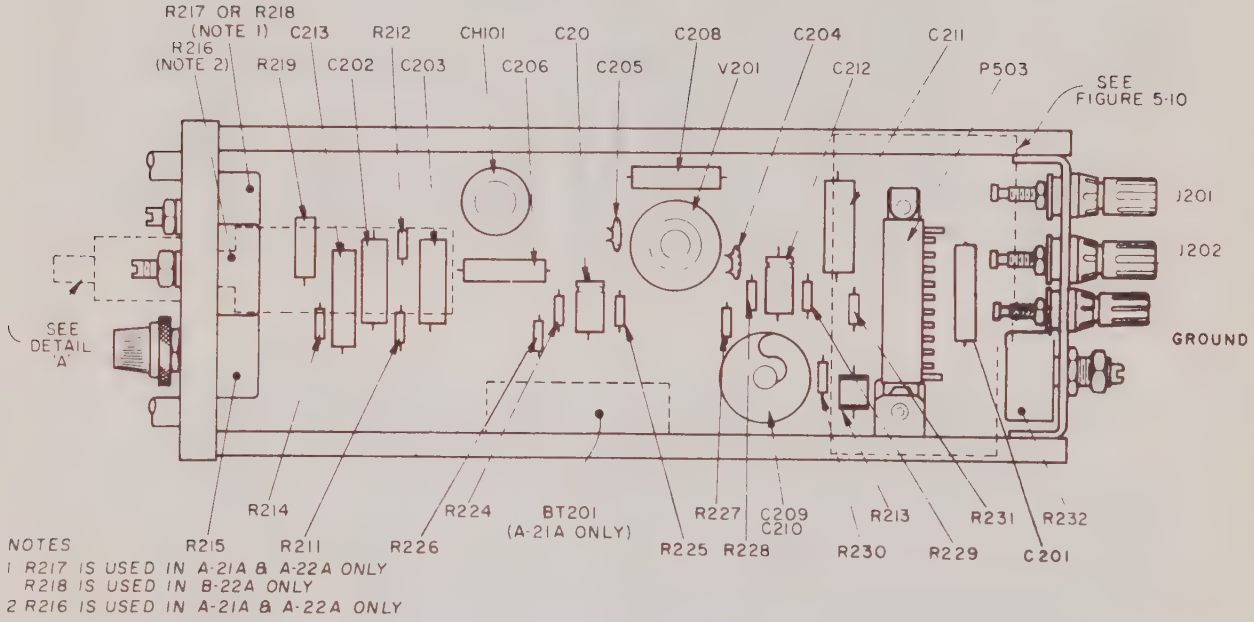
Figure 5-4: B-22A Input Chassis

5.2 A-21A, A-22A, B-22A INPUT CHASSIS

	Schematic Reference	Part Description	Varian Part Number
	BT201	Battery reference cell, 1.35v (A-21A only)	74-101-550
	C201	Capacitor, fixed, plastic, 1 μf, 200v	41-729-590
	C202	Capacitor, fixed, plastic, .47 μf, 200v	41-729-510
	C203	Capacitor, fixed, plastic, .47 μf, 200v	41-729-510
	C204	Capacitor, fixed, ceramic, 680 μμf, 1000v	41-279-779
	C205	Capacitor, fixed, ceramic, 1000 μμf, 1000v	41-279-890
	C206	Capacitor, fixed, plastic, .1 μf, 300v	41-729-516
	C207	Capacitor, fixed, electrolytic, 80 μf, 6v	41-509-999
	C208	Capacitor, fixed, plastic, .1 μf, 300v	41-729-516
	C209	Capacitor, fixed, electrolytic, 10/10 μf, 350v	41-535-990
	C210	Capacitor, fixed, electrolytic, 10/10 μf, 350v	41-535-990
	C211	Capacitor, fixed, plastic, .1 μf, 300v	41-729-516
	C212	Capacitor, fixed, plastic, 80 μf, 6v	41-509-999
	C213	Capacitor, fixed, plastic, .33 μf, 200v	41-729-515
	CH101	Chopper Air Pax	901-335
	P503	Connector Plug, 10 contacts	51-108-910
	J201	Jack, single contact (Red J201)	51-799-960
	J202	Jack, single contact (Black J202)	51-799-961
		Ground connection (for J202)	51-799-984
		Shorting Link (for J202)	905-936
*	R201	Resistor carbon film, 9 meg., 1w, 1/2%	31-999-990
*	R202	Resistor, deposited carbon, 900k, 1/2w, 1/2%	31-684-690
*	R203	Resistor, deposited carbon, 50k, 1/2w, 1/2%	31-684-550
*	R204	Resistor, deposited carbon, 30k, 1w, 1/2%	31-684-530
*	R205	Resistor, deposited carbon, 10k, 1/2w, 1/2%	31-684-510
*	R206	Resistor, deposited carbon, 5k, 1/2w, 1/2%	31-684-450
*	R207	Resistor, deposited carbon, 3k, 1/2w, 1/2%	31-684-430
*	R208	Resistor, deposited carbon, 1k, 1/2w, 1/2%	31-684-410
*	R209	Resistor, deposited carbon, 1k, 1/2w, 1/2%	31-684-410
*	R210	Resistor, variable, 250k, 2w (reference only) Part of switch assembly	962-602
	R211	Resistor, fixed, composition, 47k, 1/2w, 10%	32-202-547
	R212	Resistor, fixed, composition, 47k, 1/2w, 10%	32-202-547
	R213	Resistor, wirewound, 2k, 1%	904-351-01
	R214	Resistor, fixed, composition, 100k, 1/2w, 10%	32-202-610
	R215	Resistor, variable, 5k, 2w, 10%	36-895-451
**	R216	Resistor, variable, 25k, 2w, 10%	36-896-525
**	R217	Resistor, variable, 25k, 2w, 10%	36-999-670
	R218	Resistor, variable, 500 ohms, 2w, 10%	36-896-350
	R219	Resistor, fixed, composition, 1.2k, 1/2w, 5%	32-201-412
	R224	Resistor, fixed, composition, 47k, 1/2w, 10%	32-202-547

* R201 thru R210 used on switch Assy. (962-602) B-22A only

** R216 and R217, A21A, A22A only, R218 and R219, B22A only



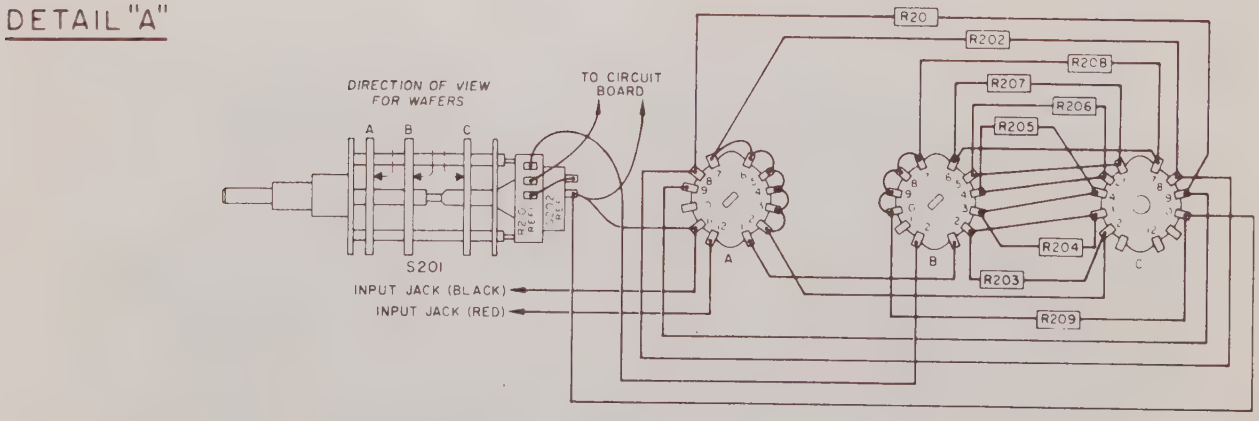


Figure 5-5: A-21A, A-22A, B-22A Parts Callout

5.2 A-21A, A-22A, B-22A INPUT CHASSIS *(Continued)*

Schematic Reference	Part Description	Varian Part Number
R225	Resistor, fixed, composition, 2.2k, 1/2w, 5%	32-201-422
R226	Resistor, fixed, composition, 220k, 1/2w, 10%	32-202-622
R227	Resistor, fixed, composition, 470k, 1/2w, 10%	32-202-647
R228	Resistor, fixed, composition, 1 meg, 1/2w, 5%	32-201-710
R229	Resistor, fixed, composition, 6.8k, 1/2w, 5%	32-201-468
R230	Resistor, fixed, composition, 47k, 1/2w, 10%	32-202-547
R231	Resistor, fixed, composition, 47k, 1/2w, 10%	32-202-547
R232	Resistor, variable, 250k, 2w, 10%	36-895-625
* S201	Switch Assembly (includes S202 and R210)	962-602
V201	Tube, electron, 12AX7	61-900-810
XBT201	Holder, reference cell	55-399-980
XCH101	Socket, 7-pin	54-279-970
XV201	Socket, 9-pin	54-279-960
	Electronic reference supply (A-22A and B-22A)	942-051
	Cable and plug (for elect. ref. sup.)	942-055

* Switch, S202, B-22A only

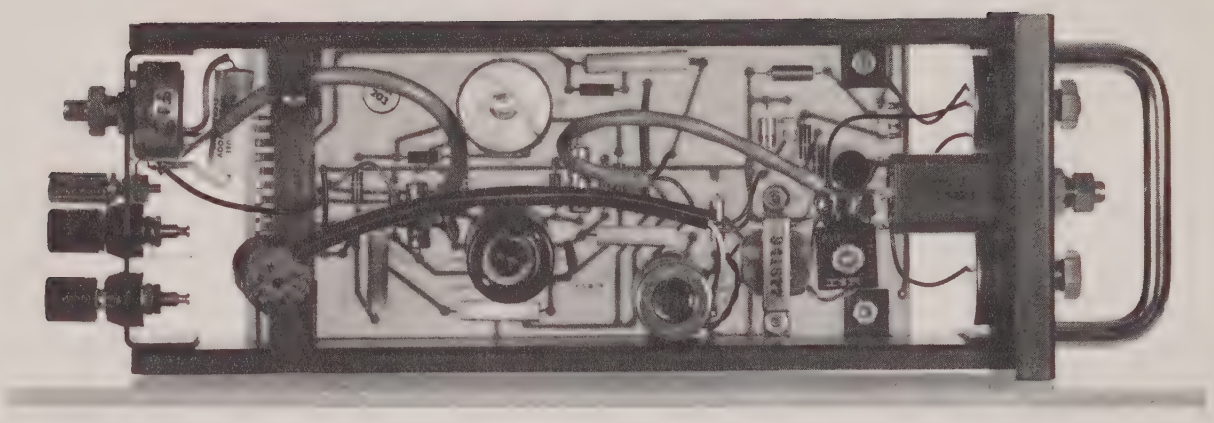
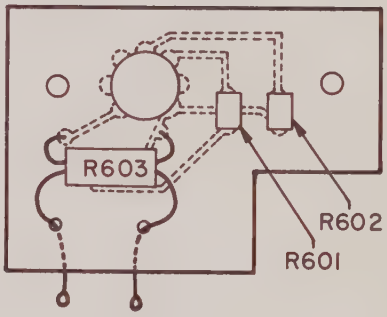


Figure 5-6: T-22A Input Chassis



DETAIL "A"

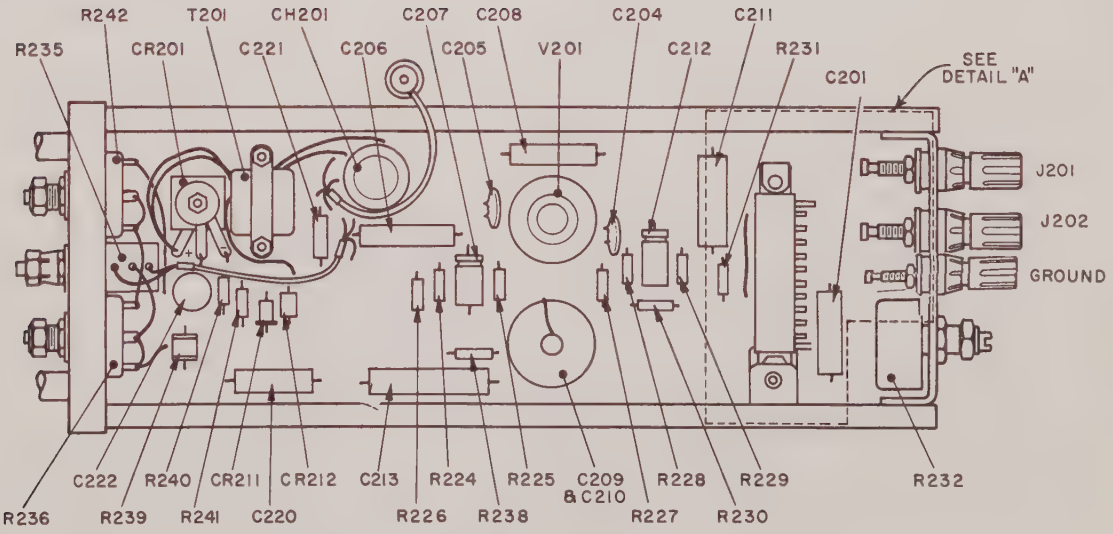


Figure 5-7: T-22A Parts Callout

5.3 T-22A INPUT CHASSIS

Schematic Reference	Part Description	Varian Part Number
C201	Capacitor, fixed, 1.0 mf, 200v	41-729-590
C204	Capacitor, fixed, 680 mmf	41-279-779
C205	Capacitor, fixed, 1000 mmf	41-279-890
C206	Capacitor, fixed, 0.1 mf, 300v	41-729-516
C207	Capacitor, electrolytic, 80 mf, 6v	41-509-999
C208	Capacitor, fixed, 0.1 mf, 300v	41-729-516
C209	Capacitor, electrolytic, 10/10 mf, 350v	41-535-990
C210	Capacitor, electrolytic, 10/10 mf, 350v	41-535-990
C211	Capacitor, fixed, 0.1 mf, 300v	41-729-516
C212	Capacitor, electrolytic, 80 mf, 6v	41-509-999
C213	Capacitor, fixed, .33 mf	41-729-515
C220	Capacitor, fixed, 22mf	41-606-931
C221	Capacitor, fixed, 22mf	41-606-931
C222	Capacitor, electrolytic, 70 mf, 25v	41-506-991
CH201	Chopper	901-335
CR201	Rectifier, selenium bridge, single phase	66-230-199
CR211	Crystal unit, rectifying, IN1513	66-301-513
CR212	Crystal unit, rectifying, 250 mw, 9v	66-302-621
J201	Binding post, modified	905-767-01
J202	Binding post, modified	905-767-02
	Ground connection (for J202)	901-515-02
	Shorting link (for J202)	905-936
P503	Connector, plug	51-108-910
R224	Resistor, fixed, 47K, 1/2w, 5%	32-201-547
R225	Resistor, fixed, 2.2K, 1/2w, 5%	32-201-422
R226	Resistor, fixed, 220K, 1/2w, 5%	32-201-622
R227	Resistor, fixed, 470K, 1/2w, 5%	32-201-647
R228	Resistor, fixed, 1 meg, 1/2w, 5%	32-201-710
R229	Resistor, fixed, 6.8K, 1/2w, 5%	32-201-468
R230	Resistor, fixed, 47K, 1/2w, 5%	32-201-547
R231	Resistor, fixed, 47K, 1/2w, 5%	32-201-547
R232	Resistor, variable, 250K	36-895-625
R235	Potentiometer, 5K, 1/2w, w.w.	906-542
R236	Potentiometer, 150 ohm, 2w, 5%	37-586-315
R238	Resistor, fixed, 82K, 1/2w, 5%	32-201-582
R239	Resistor, ww, 19K, 1/4w, 1/2%	31-299-519
R240	Resistor, fixed, 180 ohm, 1/2w, 5%	32-201-318
R241	Resistor, fixed, 220 ohm, 1/2w, 5%	32-201-322
R242	Potentiometer, 5 ohm, 2w, 5%	37-586-150

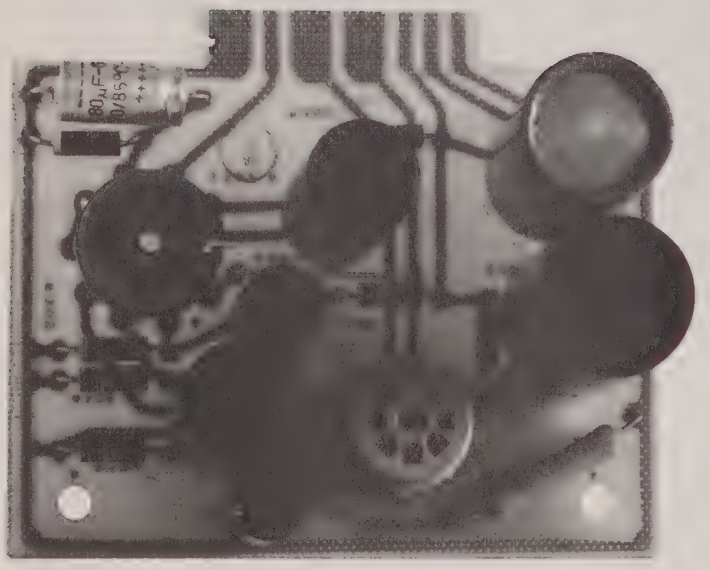


Figure 5-8: Servo Amplifier Chassis

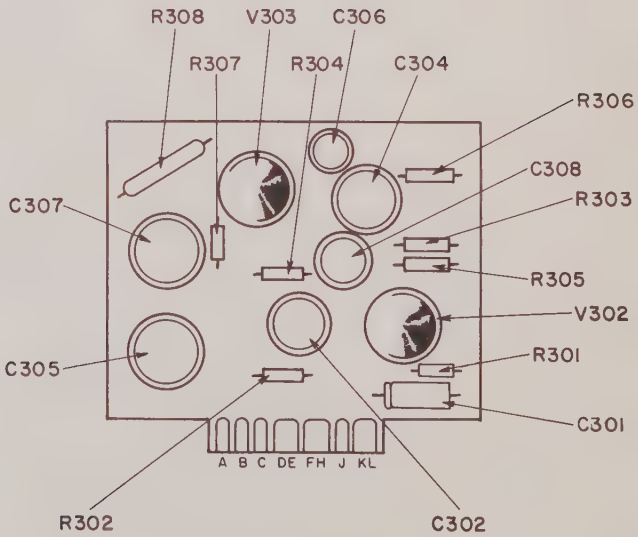


Figure 5-9: Servo Amplifier Parts Callout

5.3 T-22A INPUT CHASSIS *(Continued)*

Schematic Reference	Part Description	Varian Part Number
T201	Transformer, isolation	941-877
V201	Tube, electron, 12AX7	61-900-810
	Socket, tube, 7 pin	54-279-970
	Socket, tube, 9 pin	54-279-960
	Cable assembly, 3 conductor	905-533
	Cable, shielded, 2 conductor	88-732-298
	Cable assembly, thermocouple	906-620
	Thermocouple board assembly :	
	Platinum-platinum/rhodium, 10%	962-662-05
	Platinum-platinum/rhodium, 13%	962-662-04
	Copper-constantan	962-662-03
	Chrome-alumel	962-662-02
	Iron-constantan	962-662-01

5.4 SERVO AMPLIFIER

Schematic Reference	Part Description	Varian Part Number
	Servo Amplifier Assembly	962-727
C301	Capacitor, fixed, electrolytic, 80 μf, 6v dc	41-509-999
C302	Capacitor, fixed, plastic, .47 μf, 300v dc	41-734-950
C304	Capacitor, fixed, plastic, .47 μf, 300v dc	41-734-950
C305	Capacitor, fixed, electrolytic, 20 μf, 350v dc	41-538-990
C306	Capacitor, fixed, electrolytic, 25 μf, 50v dc	41-506-970
C307	Capacitor, fixed, plastic, 1 μf, 300v dc	41-734-951
C308	Capacitor, fixed, electrolytic, 70 μf, 25v dc	41-506-991
R301	Resistor, fixed, comp., 4.7k, 1/2w, 5%	32-201-447
R302	Resistor, fixed, comp., 330k, 1/2w, 5%	32-201-633
R303	Resistor, fixed, comp., 100k, 1/2w, 5%	32-201-610
R304	Resistor, fixed, comp., 330k, 1/2w, 5%	32-201-633
R305	Resistor, fixed, comp., 4.7k, 1/2w, 5%	32-201-447
R306	Resistor, fixed, comp., 100k, 1/2w, 5%	32-201-610
R307	Resistor, fixed, comp., 47k, 1/2w, 5%	32-201-547
R308	Resistor, fixed, comp., 1k, 5w, 5%	35-289-410
	Socket, 7-pin miniature	54-277-990
	Socket, 9-pin miniature	54-279-990
V302	Tube, electron, 12AX7	61-900-810
V303	Tube, electron, 6AQ5	61-900-375

5.5 ELECTRONIC REFERENCE SUPPLY

Schematic Reference	Part Description	Varian Part Number
	Electronic Reference supply Assy.	942-051
	Cable and plug (for elect. ref. sup.)	942-055
C401	Capacitor, fixed, electrolytic, 25 μf, 25v	41-509-997
C402	Capacitor, fixed, electrolytic, 50 μf, 12v	41-506-251
C403	Capacitor, fixed, electrolytic, 50 μf, 12v	41-506-251
CR401	Rectifier, full wave Bridge, 100 ma, 40v dc	66-230-199
CR402	Rectifier, full unit rectifying, 250 mw, 9v	66-302-621
J401	Socket, connector, 7-pin miniature	54-277-990
R401	Resistor, fixed, comp., 620 ohms, 1/2w, 5%	32-201-362
R402	Resistor, fixed, comp. 68.1 ohms, 1/2w, 1%	31-672-681
R403	Resistor, fixed, wirewound, 10k, 2w, 1/2%	904-200-01
R404	Resistor, variable, comp., 2.2k, 1/2w	942-064
R405	Resistor, fixed, wirewound, 11.5k, 2w, 1/2%	904-200-02
T401	Isolation transformer	941-877

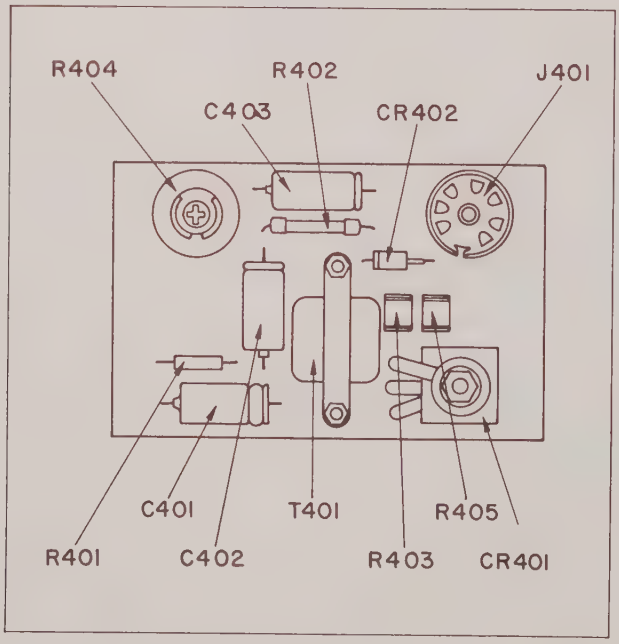


Figure 5-10: Electronic Reference Supply Parts Callout

5.6 G-22A MAIN ASSEMBLY (ELECTRICAL)

	Schematic Reference	Part Description	Varian Part Number
	B501	Servo Motor Bodine	943-356
	B502	Servo Motor Bodine	943-356
*	B503	Chart Drive Motor Assy. (Ref. only see Sec. 6)	941-739
*	B504	Chart Drive Motor Assy. (Ref. only see Sec. 6)	941-739
	C501	Capacitor, fixed, mylar, 1.5 μf, 400v	41-729-509
	C502	Capacitor, fixed, mylar, 1.5 μf, 400v	41-729-509
	C503	Capacitor, fixed, ceramic, .02 μf, 600v	41-269-889
	C504	Capacitor, fixed, ceramic, .02 μf, 600v	41-269-889
	F501	Fuse, 3 AG, 1 amp, 125v, Slo-Blo	67-136-410
		Fuse, MDL, 1/2 amp, 250v, slow blow	67-135-350
	XF501	Fuse holder (for 3AG fuse)	55-198-998
	J501	Receptacle, 10-contact	51-408-410
	J502	Receptacle, 10-contact	51-408-410
	J503	Receptacle, 10-contact	51-408-410
	J504	Receptacle, 10-contact	51-408-410
	J506	Jack accessory	51-308-112
	J507	Jack accessory	51-308-112
		contacts (for J506, J507)	51-909-930
	J505	Socket, 12-contact, female (for power supply)	51-209-712
	P506	Plug and power cord	901-187
**	R501	Resistor, variable, ww, 3k, ± 5%	941-876
**	R502	Resistor, variable, ww, 3k, ± 5%	941-876
	S501	Switch assembly	941-873
	T501	Transformer	903-418
	T502	Transformer	903-418
	TB501	Terminal Board	56-199-904

* See accessories section for complete listing of motor speeds and part numbers.

** See accessories section for options on retransmitting slide wires.

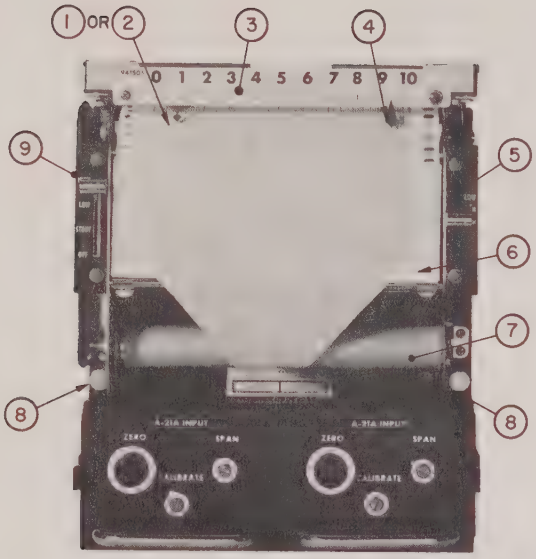


Figure 5-11:
G-22A Recorder Parts Callout Front View

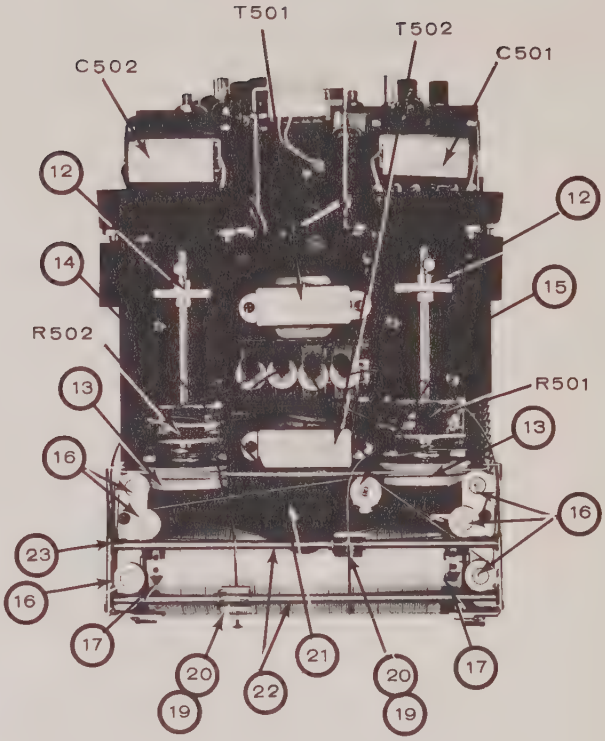


Figure 5-12: G-22A Recorder Parts Callout Top View

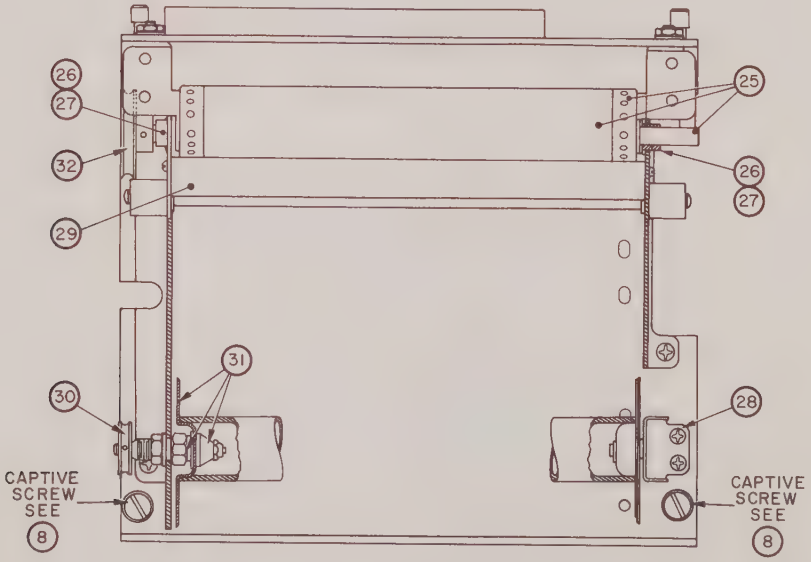


Figure 5-13: G-22A Chart Drive Parts Callout

5.7 G-22A MAIN ASSEMBLY (MECHANICAL)

Schematic Reference	Part Description	Varian Part Number
1	Rear pen kit	904-743-02
2	Rear pen zero displacement kit	904-743-03
3	Scale 0-10	941-505
4	Front pen kit	904-743-01
5	Shifter plate (low-N-high)	903-823-01
6	Paper platen	900-999
7	Re-roll tube	901-279
8	Captive screw	901-326
9	Switch plate (Low-STDBY-Off)	903-823-02
10	Collar (Stop for servo motor)	906-169
11	Roll Pin (Stop arm)	19-224-975
12	Coupling, flexible	20-269-990
13	Sheave, potentiometer	943-184
14	Guide, ink hose	903-184
15	Idler Bracket Assembly	903-828
16	Pulley, drive cord	901-028
17	Chart Clip	904-702
18	Shoulder screw (one place)	904-228
19	Bearing (pen and rod)	21-139-914
20	Grip ring	22-678-944
21	Chart trough	942-466
22	Rod, pen carriage	903-868
23	Grip ring	22-678-930
24	Shoulder screw	901-027
25	Chart drum assembly	901-095
25 ref	Part of 901-095:	
	a. Sprocket drum	900-994
	b. Sprocket	940-362
	c. Sprocket shaft	900-995
26	Bearing (sprocket shaft)	21-139-805
27	Grip ring	22-678-837
28	Chart take-up assembly	903-735
29	Pen platen	903-771
30	Pulley, chart take-up	903-866
31	Clutch assembly	900-966
32	Drive pulley	903-865
33	Gear four speed (for shifter)	901-134
34	Ink bottle assembly - includes capillary tubes	904-120
35	Latex tubing (motor stop)	88-459-990
36	Chain take-up assembly	903-871
37	Gear, chart motor	903-861

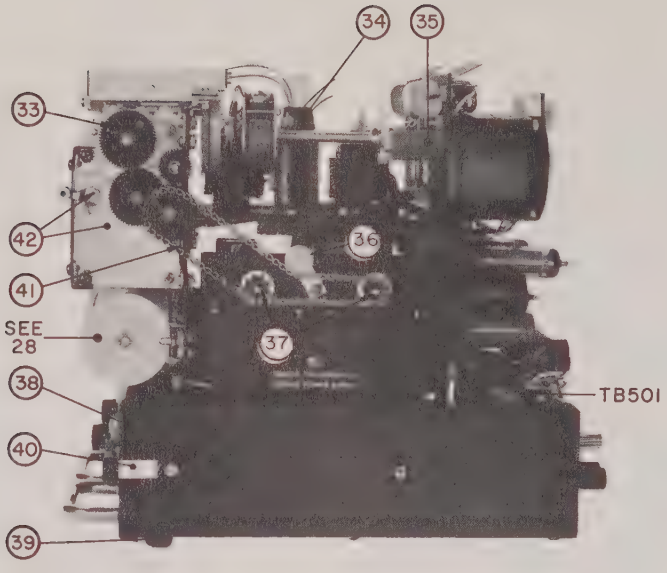


Figure 5-14: G-22A Recorder Parts Callout, R.H. Side View

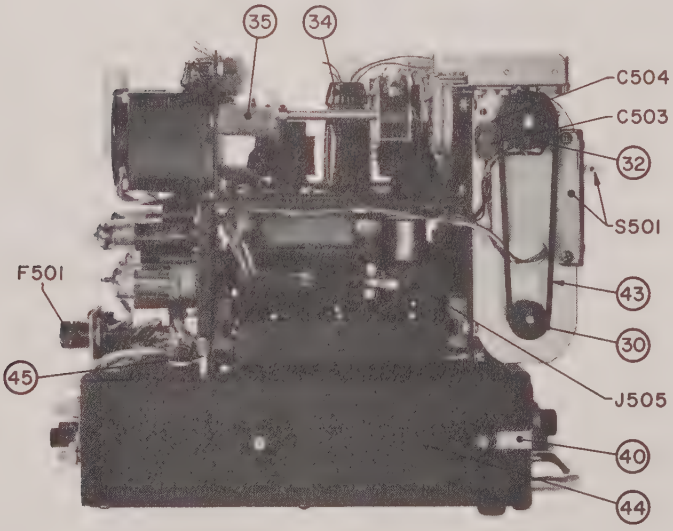


Figure 5-15: G-22A Recorder Parts Callout, L.H. Side View

5.7 G-22A MAIN ASSEMBLY (MECHANICAL) *(Continued)*

Schematic Reference	Part Description	Varian Part Number
38	Slide, R.H.	904-715-02
39	Rubber foot (2 required)	23-621-910
40	Lock input chassis	904-705
41	Drive chain	901-327-04
42	Mechanical speed changer	903-777
43	Belt, drive	20-489-990
44	Slide, L.H.	904-715-01
45	Spacer, 1/2"	22-429-968
46	Terminal strip	56-299-906
	Miscellaneous:	
	Spring, tension for drive cord	903-461
	Drive cord/includes spring, 903461	901-121-02
	Hook for drive cord	901-977
	Pen primer	904-947
	Pen cleaning wire	**972-499**
	*Pen kit, zero displacement	904-398
	*Includes:	
	1. Servo stop clamp (2)	943-014-01
	2. Servo stop clamp (2)	943-014-02
	3. Screw, phillips, 6-32 x 1/4 (4)	12-222-006-04
	4. Rear pen assembly (1)	904-387
	5. Washer, lock (4)	14-307-106

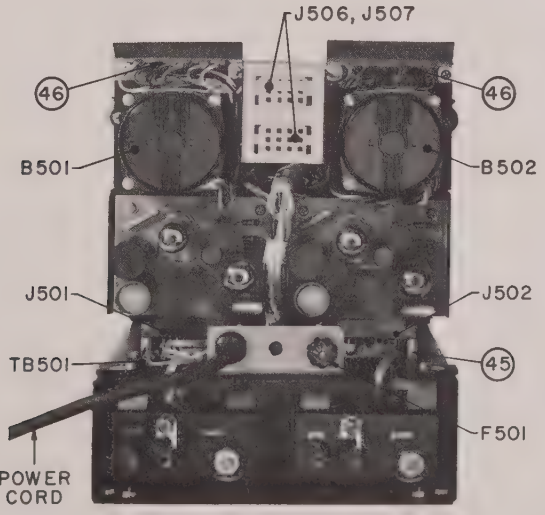


Figure 5-16: G-22A Recorder Parts Callout Rear View

accessories

6.0 G-22A ACCESSORIES

6.1 CHART DRIVE MOTORS

G-22A, 60 CYCLE

Chart Speed	Motor Speed	Part No. for Motor only	Part No. for Motor Assembly (includes gear, spade lugs, slip clutch and mounting hardware)
1/2"/hr	6RPD, 1/4 RPH	941-733-01	941-739-01
1"/hr	1/2 RPH	941-733-02	941-739-02
2"/hr	1 RPH	941-733-03	941-739-03
3"/hr	1/40 RPM	941-733-04	941-739-04
8"/hr	4 RPH, 1/15 RPM	941-733-05	941-739-05
12"/hr	6 RPH, 1/10 RPM	941-733-06	941-739-06
15"/hr	1/8 RPM	941-733-07	941-739-07
20"/hr	10 RPH, 1/6 RPM	941-733-08	941-739-08
24"/hr	12 RPH, 1/5 RPM	941-733-09	941-739-09
30"/hr	15 RPH, 1/4 RPM	941-733-10	941-739-10
60"/hr	30 RPH, 1/2 RPM	941-733-11	941-739-11
2"/min	1 RPM	941-734-31	941-739-31
4"/min	2 RPM	941-734-32	941-739-32
6"/min	3 RPM	941-734-33	941-739-33
8"/min	4 RPM	941-734-34	941-739-34
* 12"/min	3 RPM	941-734-33	941-739-35
15"/min	7-1/2 RPM	941-734-36	941-739-36
* 16"/min	4 RPM	941-734-34	941-739-37

DUMMY MOTOR ASSY. 903873

G-22A, 50 CYCLE

Chart Speed	Motor Speed	Part No. for Motor only	Part No. for Motor Assembly (includes gear, spade lugs, slip clutch and mounting hardware)
1/2"/hr	6 RPD, 1/4 RPH	941-733-13	941-739-13
1"/hr	1/2 RPH	941-733-14	941-739-14
2"/hr	1 RPH	941-733-15	941-739-15
3"/hr	1/40 RPM	941-733-16	941-739-16
8"/hr	4 RPH, 1/15 RPM	941-733-17	941-739-17
12"/hr	6 RPH, 1/10 RPM	941-733-18	941-739-18
15"/hr	7-1/2 RPH, 1/8 RPM	941-733-19	941-739-19
20"/hr	10 RPH, 1/6 RPM	941-733-20	941-739-20
24"/hr	12 RPH, 1/5 RPM	941-733-21	941-739-21
30"/hr	15 RPH, 1/4 RPM	941-733-22	941-739-22
60"/hr	30 RPH, 1/2 RPM	941-733-23	941-739-23
2"/min	1 RPM	941-734-39	941-739-39
4"/min	2 RPM	941-734-40	941-739-40
6"/min	3 RPM	941-734-41	941-739-41
8"/min	4 RPM	941-734-42	941-739-42
* 12"/min	3 RPM	941-734-41	941-739-43
15"/min	7-1/2 RPM	941-734-44	941-739-44
* 16"/min	4 RPM	941-734-42	941-739-45

DUMMY MOTOR ASSY. 903873

6.2 PORTABLE CASE ASSEMBLY

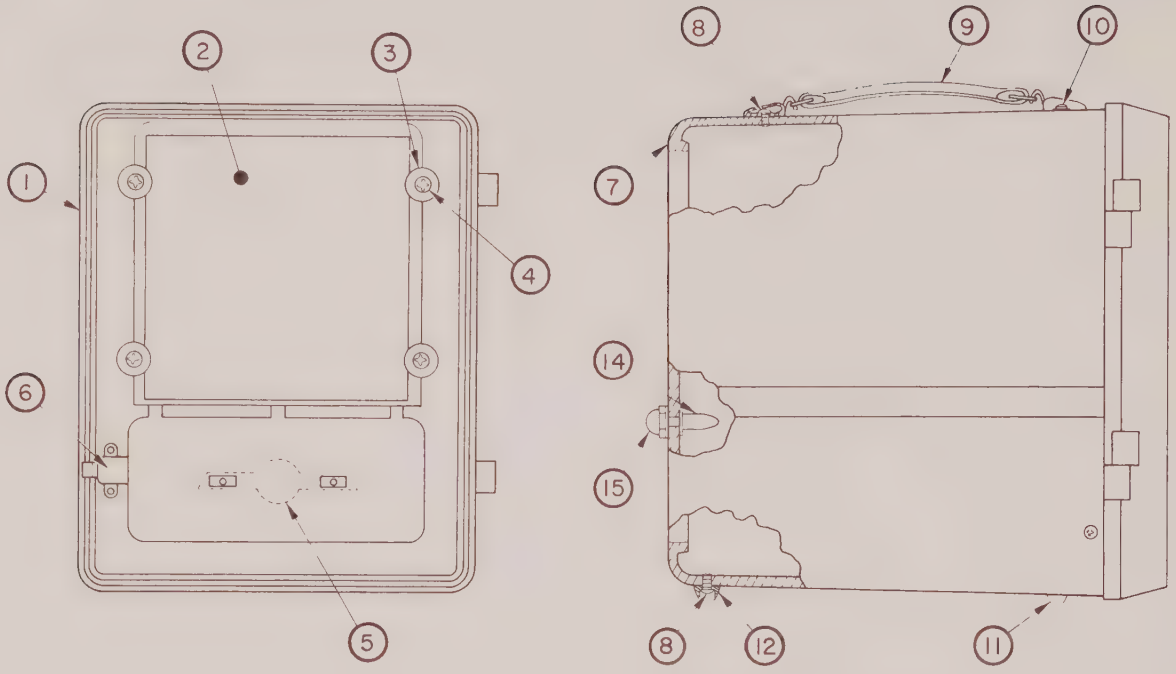


Figure 6-1: Portable Case Assembly Parts Callout

Reference Number	Part Description	Varian Part No.
	Recorder Cover Assembly	961-402
1	Door, case cover	904-081
2	Window, case cover	904-082
3	Washer, fiber	904-083
4	Screw, self tap, 6-32 x 1/4	10-601-106-04
5	Nameplate	901-469-04
6	Door lock (includes keys)	23-649-980
	Portable Case Assembly (Complete)	961-407-01
7	Case only	970-584
8	Screw, 6-32 x 3/16	12-222-006-03
9	Handle Assembly	23-639-900
10	Screw, 10-32 x 1/4	12-222-060-04
11	Foot, 1/2 O.D. x 1/4 High	23-621-908
12	Foot, 5/8 O.D. x 5/16 High	23-621-910
13	Cap nut, 1/4 x 28	13-324-364
14	Guide, pin	904-109
15	Stud, sliding	904-717

6.3 SINGLE RACK MOUNTING

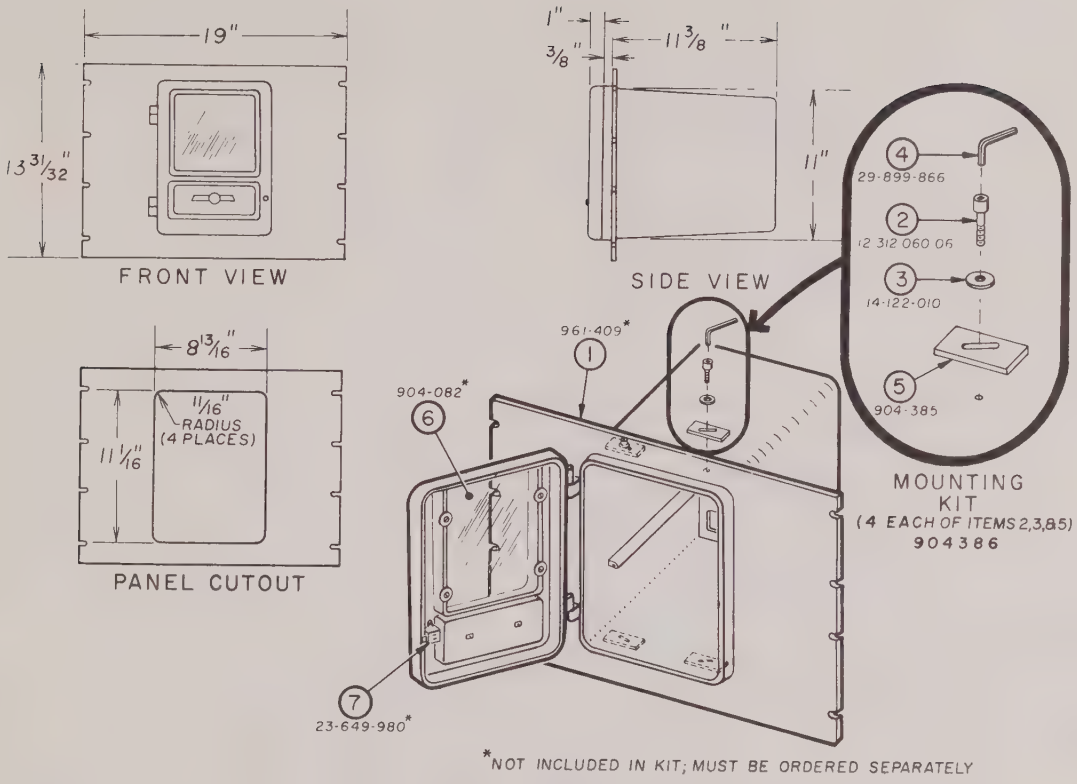


Figure 6-2: Single Rack Mounting Parts Callout

Reference Number	Part Description	Varian Part No.
	Conversion Kit (Portable to Panel)	904-386
	Kit includes:	
5	Block, mounting (4)	904-385
4	Wrench, Allen (1)	29-899-866
3	Washer, flat (4)	14-122-010
2	Cap Screw, hex socket (4)	12-312-060-06
	Not included in kit:	
1	Panel	961-409
6	Window	904-082
7	Latch (door lock)	23-649-980

6.4 DUAL RACK MOUNTING

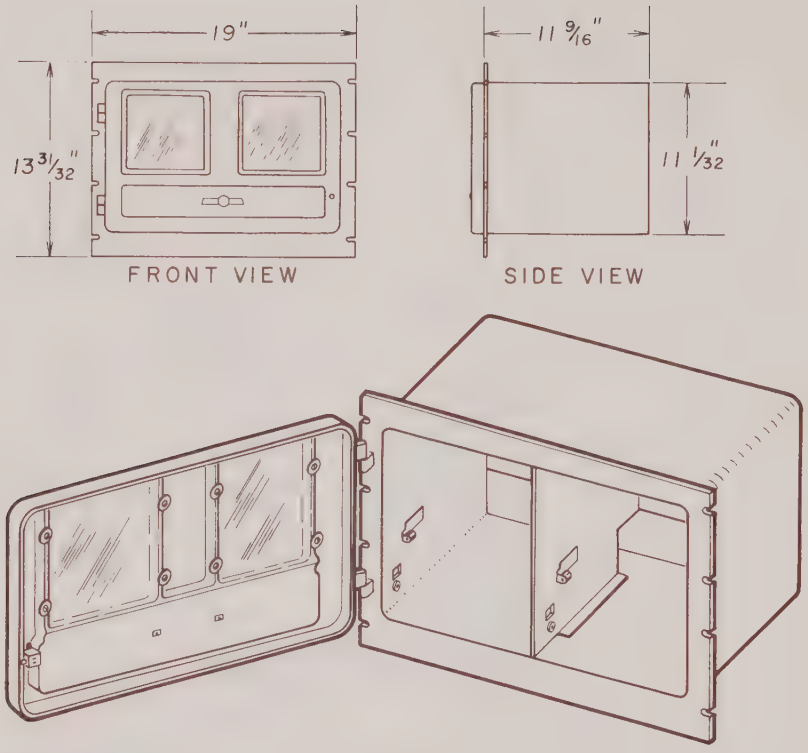


Figure 6-3: Dual Rack Mounting Pictorial

6.5 RETRANSMITTING POTENTIOMETER

The retransmitting potentiometer simply replaces the standard potentiometer, R501 R502, part number 941-876. Refer to Sections 4.3.3 and 4.3.4 for the replacement procedure and phasing procedure. The retransmitting potentiometer has two sections, section 1 (near the short-shaft end) is identical to the standard potentiometer and has a total resistance of 3000 ohms.

Three shelf-item versions of the retransmitting potentiometer are available. The total resistance of section 2 in these versions is listed below. When ordering, specify the kit number and the number of kits desired.

Kit No. 961-555-01	1000 ohms total resistance
Kit No. 961-555-02	5000 ohms total resistance
Kit No. 961-555-04	100 ohms total resistance

NOTE: Other resistance values for section 2 are available on special order.

6.6 INSTALLATION AND OPERATION OF G-22A EVENT MARKERS

Part Number: 942728-01 (Left Channel)
-02 (Right Channel)
-03 (Both Channels)

6.6.1 Preparation

Recorders prior to Serial No. 236 require two new chart clips (904702) and a new chart trough (942466). These items must be mounted before the event markers are installed.

On a few early model recorders it will be necessary to drill two holes in *each* pulley bracket as shown in Figure 6-4. *Be sure to disconnect the recorder power cord from the line before drilling any holes or performing installation.* Remove the takeup belt to prevent damage to it while drilling. Take precautions to keep metal chips out of the gears, switches, and other delicate parts. These holes will be used to hold the event

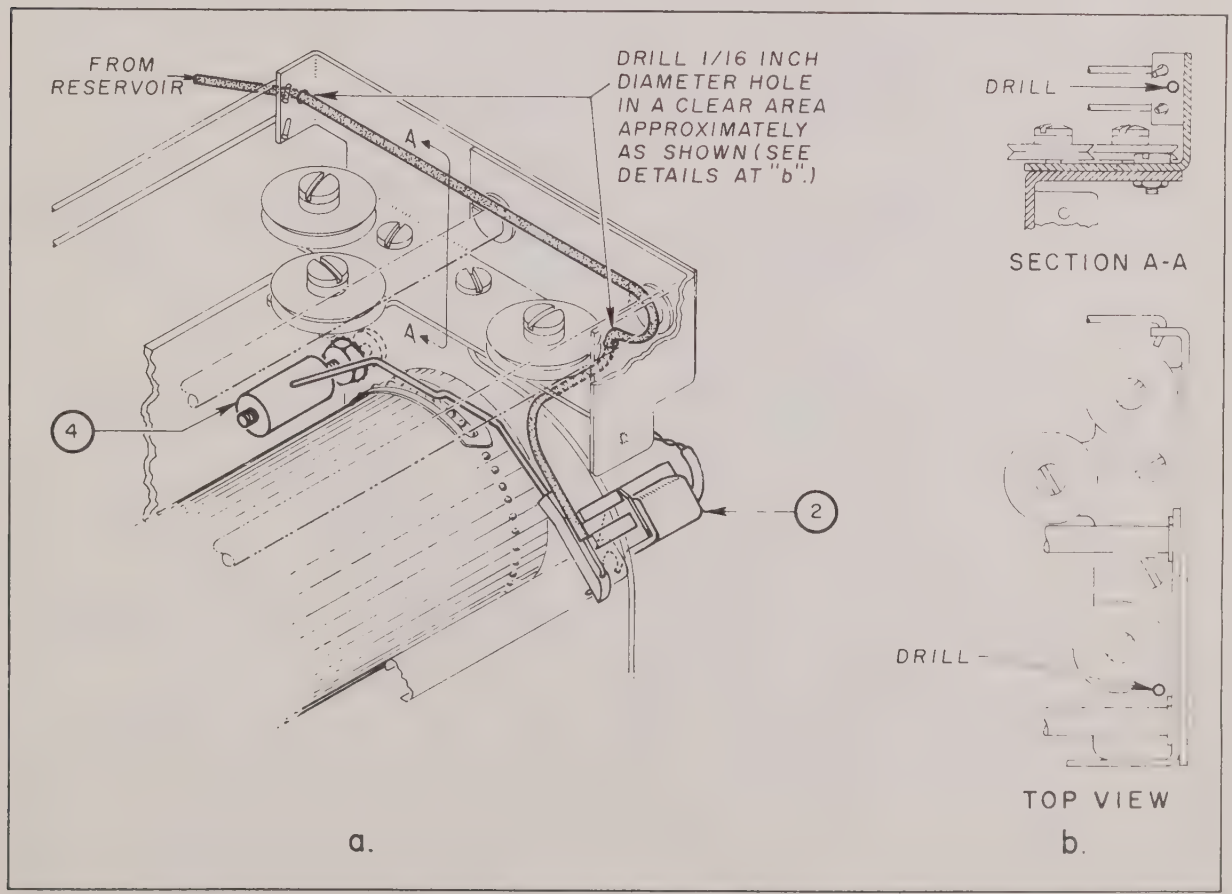


Figure 6-4: Event Marker Orientation

marker ink lines in position. The exact location of these holes is not critical.

A few recorders are also lacking a hole on the left side (facing the front of the recorder) for mounting the left channel pen assembly. This hole must be carefully positioned. See Figure 6-5a for size and location details. Caution: one metal chip could ruin the on-off wafer switch. After the hole is drilled, replace the takeup belt.

If the recorder Serial No. is 236 or higher, and if all of the required holes are present, no preparation is necessary.

6.6.2 Magnet Installation

6.6.2.1 Left Channel Magnet

(1) Loosen the screw which holds the pen platen.

(2) Insert slot of the left channel magnet assembly under the platen-screw washer, and retighten the screw.

(3) See Figure 6-5a for magnet orientation and magnet lead dress behind the pulley. The leads are continued along the left side cable, either by tying them to the cable or by winding them around the cable two or three turns.

(4) Then dress the leads along the central cable toward the rear and on down to where they will connect to the event marker power supply which will be mounted at the left rear of the recorder.

NOTE

For easier dressing of leads, remove recorder power supply.

(5) Tie the magnet leads to the main cable in two or three places if only the left channel event marker is to be installed.

(6) Do not tie the magnet leads to the cable at this time if event markers are to be installed on both channels.

(7) In either case (5) or (6) do not cut the leads to length until the proper time during the power supply installation.

6.6.2.2 Right Channel Magnet

(1) Loosen the screw which holds the pen platen.

(2) Insert the slot of the right channel magnet assembly under the platen-screw washer and retighten the screw.

(3) See Figure 6-5b for magnet orientation and magnet lead dress above and behind the gears.

(4) Install cable clamp (item 11) with screw (item 8).

(5) Dress the magnet leads under the pen cartridge bracket, then under the transformer, then follow

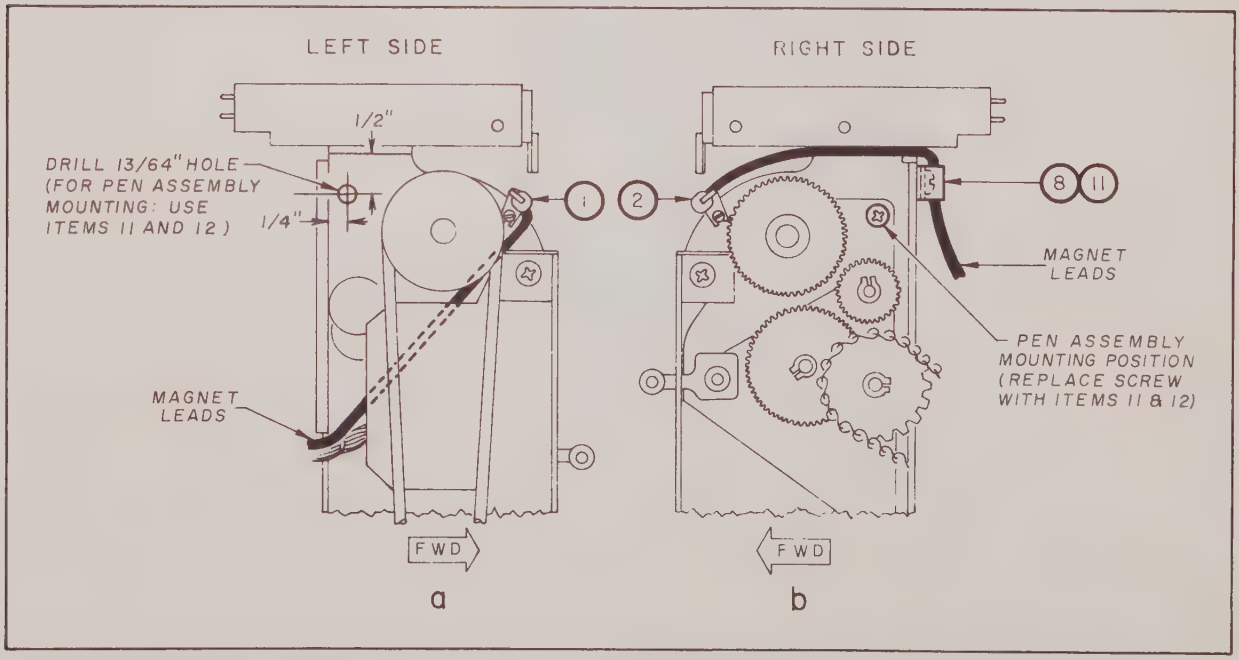


Figure 6-5: Event Marker Magnet Orientation

the central cable down to where they will be connected to the event marker power supply.

(6) Tie the magnet leads to the main cable in several places. Check to be sure the magnet leads do not interfere with any moving parts. Do not cut the leads to length at this time.

6.6.3 Power Supply Installation

(1) Remove the left channel amplifier board to prevent damage to the board while soldering the event marker power supply leads to the amplifier connector. After removing two screws, the amplifier board may be lifted out of the connector and set aside.

(2) Refer to Figures 6-6 and 6-7. Solder the red wire to the *fifth* terminal from the left. Solder the blue wire to the *sixth* terminal from the left. These connections provide 6.3 vac to the power supply.

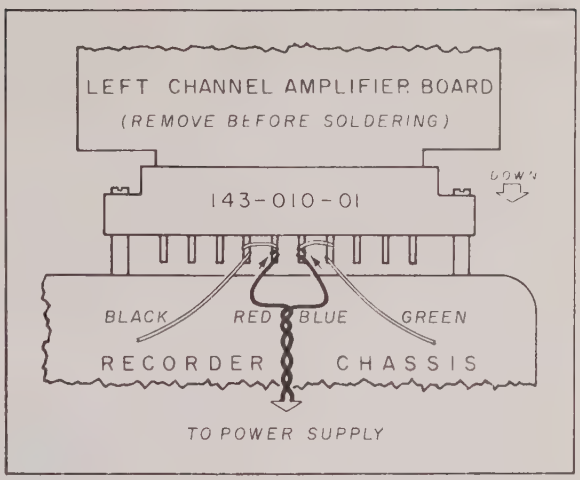


Figure 6-6: Wiring Power Supply to Amplifier Board

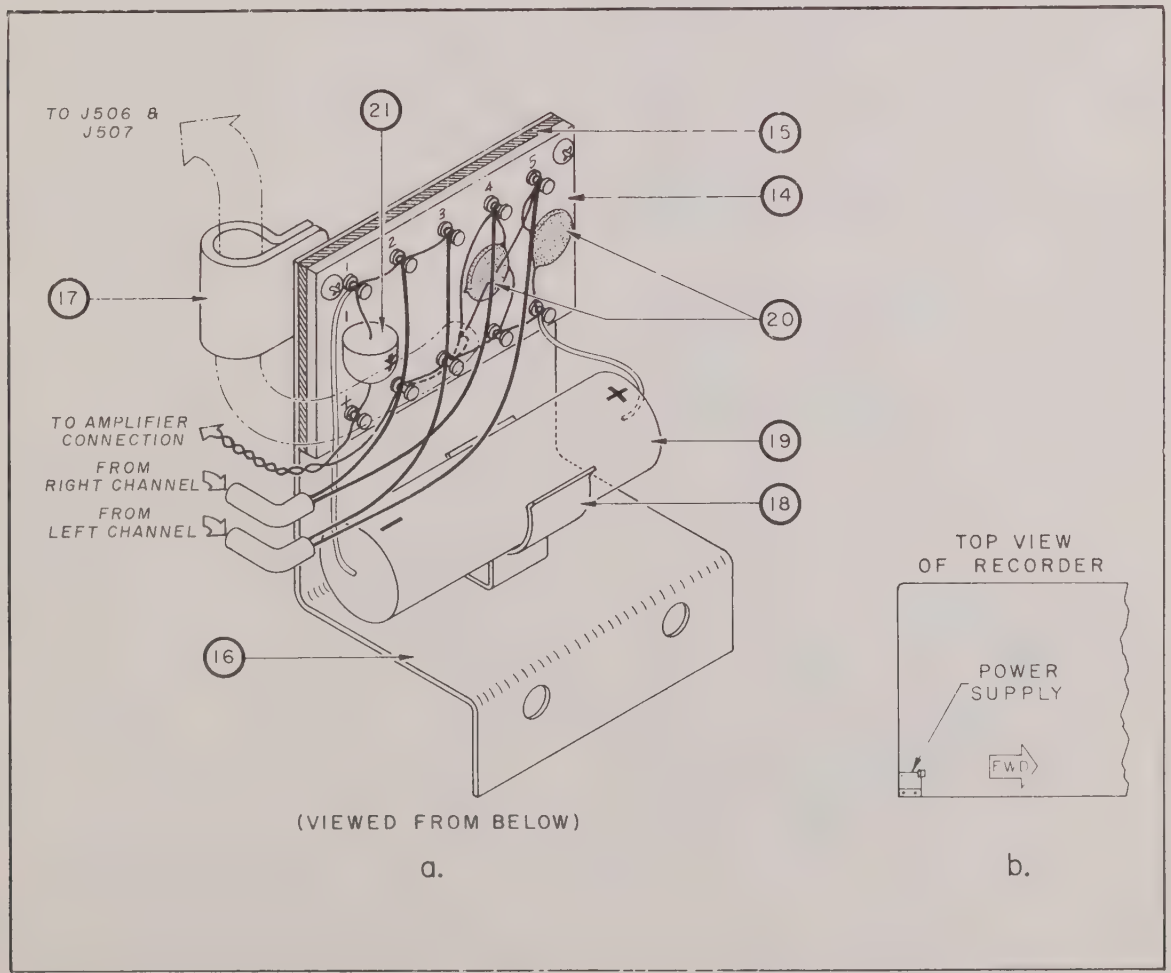


Figure 6-7: Event Marker Power Supply

(3) Replace the amplifier board.

(4) Refer to Figure 6-7, a pictorial diagram of the power supply, Figure 6-8, showing how the power supply is mounted, and Figure 6-11, the event marker schematic.

(5) Remove recorder power supply, then trim the magnet leads to length.

(6) Connect one of the leads from the left channel magnet to terminal 3.

(7) Connect the other lead of the left channel to terminal 5.

(8) Connect one of the leads from the right channel magnet to terminal 2.

(9) Connect the other lead of the right channel to terminal 4.

(10) Remove the nylon pad on the left side of the recorder. (A few early recorders may not have the nylon pad. The lack of this pad will not inhibit the installation of the event marker power supply.)

(11) Refer to Figures 6-7 and 6-8. Place bracket of the power supply under the nylon pad in position as shown on the recorder chassis and secure. In addition, secure with screw (item 5) and nut (item 6.) Check for clearance between power supply and fuse holder.

(12) Refer to Figure 6-9. Insert the contacts at the ends of the black and white wires into the plug connectors (J506 and J507) at the rear of the recorder. The white wires go to pins 9 and 10 of J506 (upper connector). The black wires go to pins 9 and 10 of J507 (lower connector). Spare contacts are included with this kit (item 7).

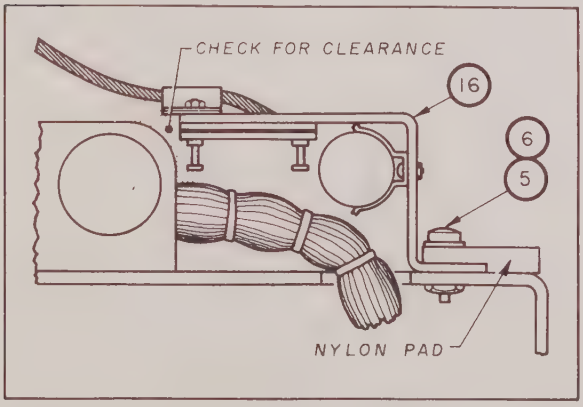


Figure 6-8: Power Supply Location

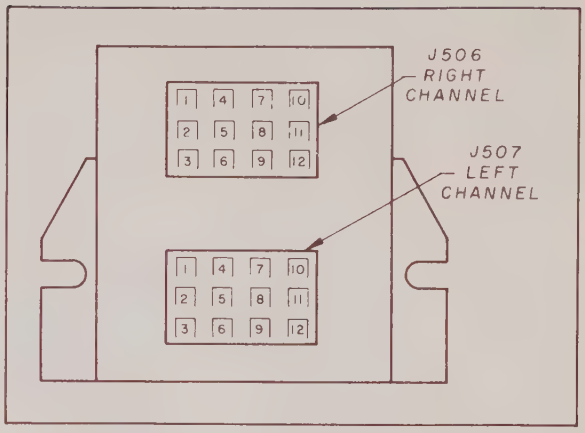


Figure 6-9: Accessory Connector Plugs

6.6.4 Pen Installation

The pen installation procedure for the two channels is identical. See Figures 6-4 and 6-10 for pen orientation and adjustment. The long screw (item 9) provides the mount and pivot for the pen assembly. On the right channel side, it replaces the screw already in the gear plate.

(1) Adjust for 1/32-inch clearance between the pen holder and the magnet tips by turning the screw (item 9) and locking it with the keps nut (item 10).

(2) Align magnet with pen holder and check for freedom of movement of the pen.

(3) Remove the pen primer unit(s) from the accessory kit. Run the capillary tubes as shown in Figures 6-4 and 6-10. Insert the piercing element of the pen primer unit(s) into the top of the available ink cartridge(s). Slip the free end of the capillary tube(s) over the end of the pen assembly(s).

(4) Arrange the hose so that it DOES NOT RESTRICT PEN MOVEMENT. Check for clearance between pen holder spring wire and chart clip. Check for clearance between pen holder and chart scale.

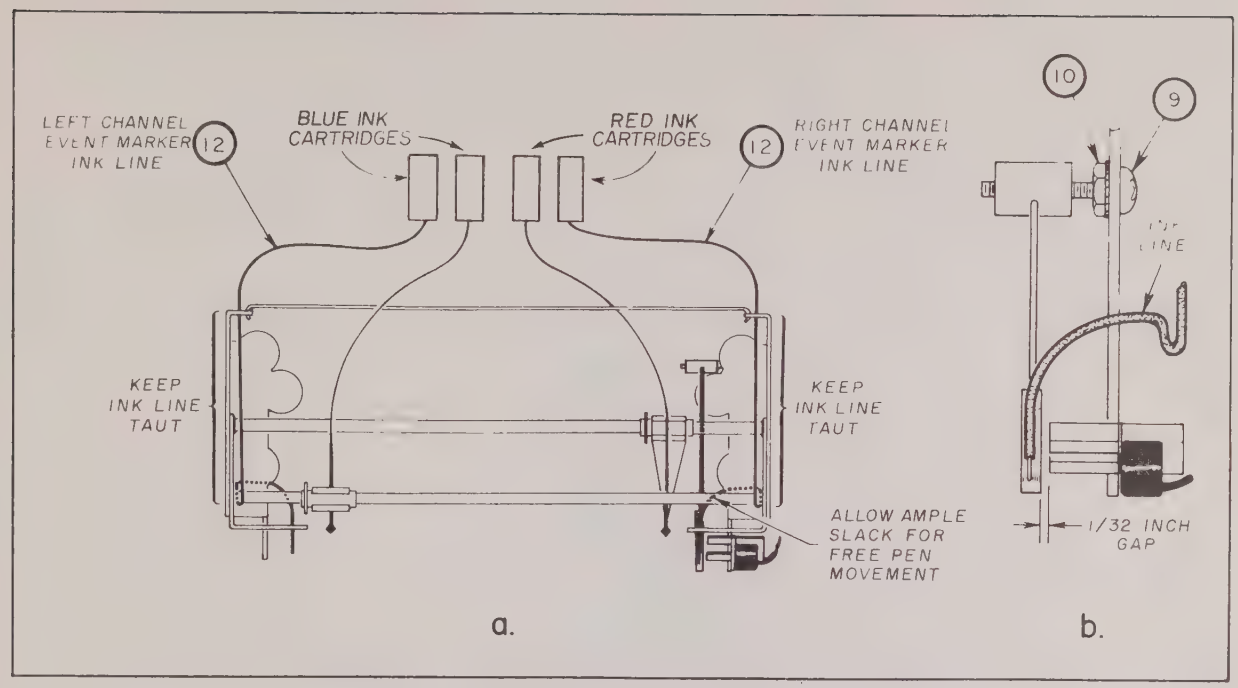


Figure 6-10: Event Marker Pen Orientation

6.6.5 Operation

(1) Plug the power cord into the line.

(2) Check actual operation of the pens by momentarily inserting a jumper wire into pins 9 and 10 of each connector plug. Slight readjustment of magnet position or pen position may be necessary for satisfactory operation.

(3) Align each event marker pen to coincide with the appropriate recorder pen on the same time line of the chart by slightly bending the spring of the event marker pen assembly if necessary. Check again to be sure magnet leads and ink lines are clear of moving parts.

(4) Prime the event marker pens and check operation while running chart paper as in (2) above. The event markers may be left energized for an indefinite period of time, either singly or together.

It should be emphasized that the event markers are *self-powered*. All they require externally is two wires connected to a push button or any sort of switch or relay contacts that will connect the two wires together when desired. *The event marker wires must never be included as part of another circuit where voltage is present.* If an event represented by a voltage is to be marked, connect the event marker to a spare set of contacts on a relay in the external circuit, or have a solenoid operate a switch.

WARNING

DO NOT APPLY VOLTAGE to the event markers or ground any portion of the circuitry. The floating potential which appears at the negative lead of the input chassis is also across the leads of the event marker. The event markers MUST NOT BE GROUNDED. They must remain floating.

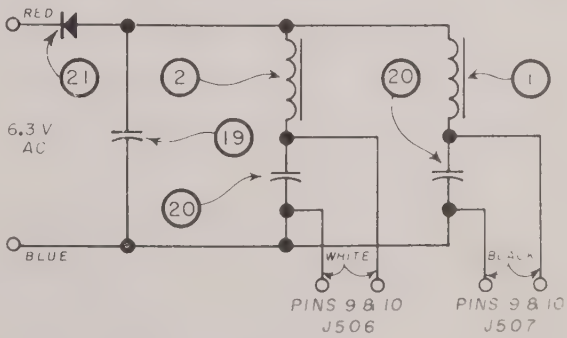


Figure 6-11: Event Marker Schematic

EVENT MARKER PARTS LIST, 942-728-01 THROUGH -03

Item	Quantity -01,	-02,	-03	Description	Varian Part No.
1	1	-	1	Magnet Assembly (left)	904-531-01
2	-	1	1	Magnet Assembly (right)	904-531-02
3	1	-	1	Pen Assembly (left)	942-677-01
4	-	1	1	Pen Assembly (right)	942-677-02
5	1	1	1	Screw, 6-32 x 3/8	12-222-006-06
6	1	1	1	Nut, Keps, 6-32	13-311-106
7	2	2	4	Contact	51-909-930
8	-	1	1	Screw, 6-32 x 1/2	12-222-006-08
9	1	1	2	Screw, 8-32 x 1-1/4	12-222-008-22
10	1	1	2	Nut, Keps, 8-32	13-311-108
11	-	1	1	Clamp, cable	22-119-802
12	1	1	2	Ink Hose, 12 in. long	28-159-590
13	1	1	1	Power Supply Assembly	942-679

POWER SUPPLY PARTS LIST

(The following items are included in Item 13, above)

14	1	1	1	Circuit Board	904-934
15	1	1	1	Insulator Board	904-933
16	1	1	1	Bracket	904-823
17	1	1	1	Clamp, cable	22-119-804
18	1	1	1	Clamp, capacitor	22-129-992
19	1	1	1	Capacitor, fixed, elect., 500 μf, 10v dc	41-509-790
20	2	2	2	Capacitor, fixed, ceramic, .02 μf, 150v dc	41-229-020
21	1	1	1	Diode, silicon, Sarkes-Tarzian F-2	66-397-938

NOTE:

For each recorder prior to Serial No. 236, two new chart clips (904-702) and one new chart trough (942-466) are required. These items are not included in this kit.

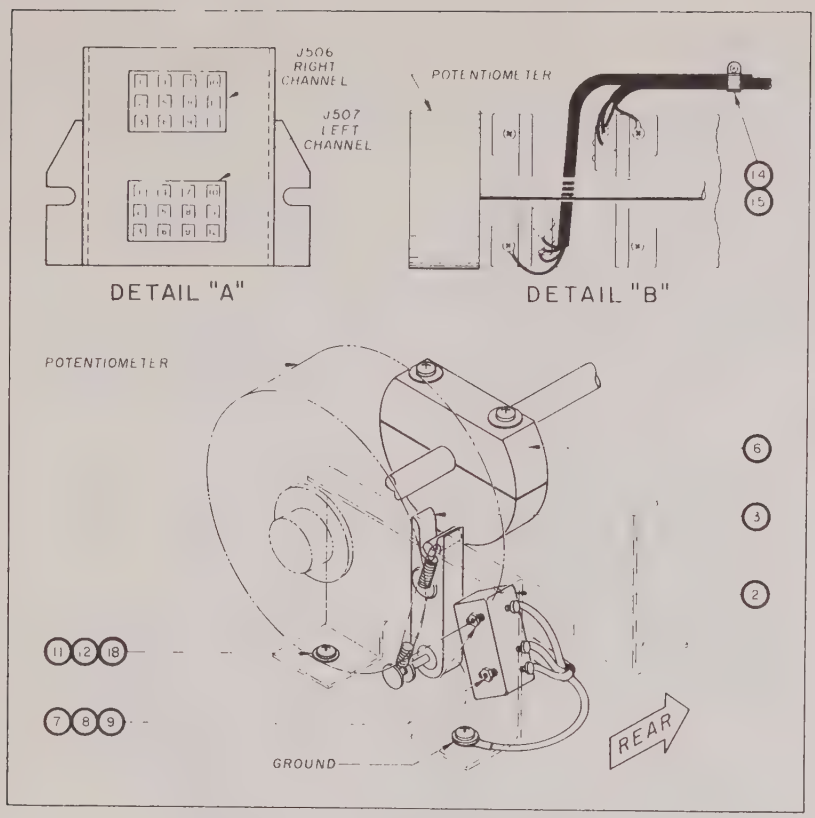


Figure 6-12: Alarm Parts Orientation

6.7 G-22A ALARM CONTACT KIT INSTALLATION

6.7.1 General

One, two, three, or four Alarm Contact Kits may be installed in each G-22A Recorder. Alarm Contact Kit 941870-01 is intended for right channel operation (facing front of recorder). Alarm Contact Kit 941870-02 is intended for left channel operation. Figure 6-12 shows parts orientation for right channel installation. Detail A shows pins arrangement of the plugs for convenience in installation. Left channel installation is very similar to right channel. See Section 6.7.3 of these instructions.

6.7.2 Right Channel Installation (Part Number 941870-01)

(1) Install Bracket with screws (11) and washers (12) and spacers (18). Refer to Figure 6-12.

(2) Secure the Trip Wheel Assembly (6) to the potentiometer shaft so that the pin engages Toggle Arm (3). Allow clearance between trip wheel and toggle arm. Be sure that the trip wheel will throw toggle arm against bracket away from switch. Check toggle action in both directions.

(3) Run cable as shown in Detail B. Remove existing cable clamp and replace with item (15).

(4) Secure contact (13) to white wire of cable. If two switches are installed on the right channel, the two white wires are connected together and secured to contact (13).

(5) Insert contacts at end of cable(s) into plug connector J506 (top connector) of recorder as follows:

	Wire Color	Pin
Front-Mounted Kit:	Black	4
	Red	5
Rear-Mounted Kit:	Black	7
	Red	6
Common for either or both switches:		8

(6) Set trip wheel in desired relation to potentiometer shaft position.

(7) Install red Pointer(s) item (16) on recorder scale at switch operating position.

6.7.3 Left Channel Installation (Part Number 941870-02)

Left channel installation is identical to the procedure for the right channel except:

In step (3), use item (14) instead of item (15). Use care when securing cable so that it does not interfere with movement of servo shaft stop arm.

In step (5), insert contacts into plug connector J507 (lower) using the same code.

In step (7), use blue Pointer(s) item (17) instead of item (16).

6.7.4 Arc Suppression

If a circuit such as the one shown in Figure 6-13(a) is connected to the alarm contacts, arcing is likely to occur as the contacts open. Inductive loads such as motors, relay coils, and solenoids tend to cause the most trouble. The stored energy in an inductive circuit creates a voltage which tends to keep the current flowing when the switch contacts open. If the voltage build up is fast enough and high enough to exceed the dielectric strength of the air between the switch contacts, an arc will occur.

Arcing reduces the life of a switch by deteriorating the mating surfaces of the contacts. An arc also generates a radio-frequency pulse of energy which may interfere with proper operation of recorder servo system or introduce noise in other sensitive electronic equipment. A certain amount of care in the design of external circuitry is required for best performance.

6.7.4.1 Shielding

All external leads which are connected to the recorder must be shielded with the shield connected to ground. This will minimize the effect of any arcing that may occur. The inside leads connecting the alarm contacts to the connector plug at the rear of the recorder are shielded for this same reason.

6.7.4.2 Arc Suppressing Circuits

The purpose of the additional components in the circuitry to be described is to reduce the rate of voltage rise and the peak voltage across switch contacts.

In Figure 6-13(b), a diode has been added across the inductive load. The diode is biased in the reverse direction when the switch is closed and little current flows through it. When the switch is opened, the voltage generated by the inductance appears across the diode in the forward direction and current passes through it, gradually decreasing as energy is dissipated in the resistance of the circuit. This circuit can only be used in d c systems. If the load is highly inductive, the induced voltage in this circuit may decay more slowly than desired. For instance, if the load is a relay coil, the delay between the switch opening and the relay dropping out may be excessive.

In Figure 6-13(c), a resistance and capacitance are connected across the load. When the switch is opened, a damped sine wave results (if $Q \leq 1$). If capacitor, C,

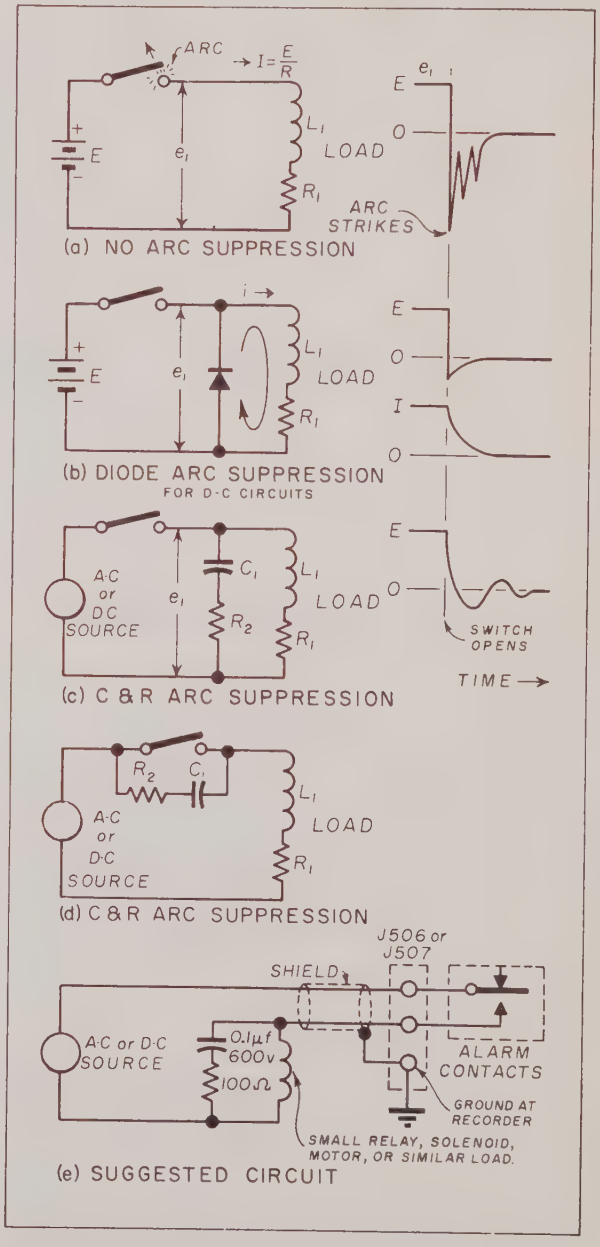


Figure 6-13: Alarm Contact Circuits

is chosen to be large enough, the rate of change of voltage and the peak voltage across the contacts, is reduced to a point where an arc cannot develop. Resistor R_2 is necessary to limit the surge of charging current (when the switch closes) to a value within the rating of the switch contacts. Typical values for R_2 and C are 10 to 1000 ohms and .05 to 1 mfd.

The circuit in Figure 6-13(d) is very similar in performance to the circuit in Figure 2-c and either can be used with a c power sources. In this circuit, some current will flow through R_2 and C to the load when the switch is open.

If long leads are used, the inductance of the leads themselves may cause an arc. In such a case, the arc suppression components should be placed near the switch.

The suggested circuit in Figure 6-13(c) will serve in most applications.

The current rating of the switch used for the alarm contacts is as follows: 5 amperes at 125 to 250 volts ac; 3 amperes at 30 volts dc.

ALARM CONTACT PARTS LIST

(Each kit consists of the following parts)

941870	-01	-02		
Item	Quantity		Description	Varian Part No.
1	1	1	Bracket	941-869
2	1	1	Switch Assembly	904-587
3	1	1	Toggle Arm Assembly	903-958
4	1	1	Shaft	904-779
5	1	1	Spring	903-461
6	1	1	Trip Wheel Assembly	903-956
7	2	2	Screw, #2-56 x 3/8	12-104-502-06
8	2	2	Lockwasher, #2, split	14-207-002
9	2	2	Nut, #2-56	13-104-502
10	1	1	Grip Ring	22-678-600
11	2	2	Screw, #6-32 x 1/4	12-222-006-04
12	2	2	Lockwasher, #6, int. tooth	14-307-106
13	1	1	Contact, Amplock	51-909-930
14	-	1	Cable Clamp	22-119-806
15	1	-	Cable Clamp	22-119-810
16	1	-	Pointer	904-778-01
17	-	1	Pointer	904-778-02
18	2	2	Spacer	

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